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RENTSCHLER FIELD EAST HARTFORD, CONNECTICUT

WORK PLAN SOIL AND GROUND WATER CHARACTERIZATION

MAY 2000

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Prepared for:

STATE OF CONNECTICUT OFFICE OF POLICY AND MANAGEMENT
HARTFORD, CONNECTICUT

Prepared by:

MARIN ENVIRONMENTAL, INC.
HADDAM, CONNECTICUT

Reference No. 99-0581

CONNECTICUT
7 ISLAND DOCK ROAD
HADDAM CT 06438
PHONE 860.345.4578
FAX 860.345.3854
TOLL FREE 1.800.524.9256

MASSACHUSETTS
600 CHARLTON STREET
SOUTHBRIDGE MA 01550
PHONE 508.764.8755
FAX 508.764.4054
TOLL FREE 1.800.676.3707

LAKESIDE OFFICE PARK
599 NORTH AVENUE SUITE 6-4
WAKEFIELD MA 01880
PHONE 781.246.8897
FAX 781.246.8950
TOLL FREE 1.800.344.1958

NEW HAMPSHIRE
114 SOUTH STATE STREET
PO BOX 1414
CONCORD NH 03302
PHONE 603.224.8871
FAX 603.224.8688
TOLL FREE 1.800.636.6030

VERMONT
73 MILLET STREET
RICHMOND VT 05477
PHONE 802.434.4500
FAX 802.434.6076
TOLL FREE 1.800.520.6065

Satellite Office:
NEW YORK
116 CONSUMER SQ., #174
PLATTSBURGH NY 12901
PHONE 518.566.8297
TOLL FREE 1.800.520.6065

INTERNET:
WWW.MARINENV.COM

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1.0 INTRODUCTION

The State of Connecticut, Office of Policy and Management (OPM) has requested that Marin Environmental, Inc. (Marin) develop this proposed Work Plan for the further evaluation and characterization of soil and ground water at Rentschler Field, located in East Hartford, CT. The purpose of the Soil and Ground Water Characterization Plan (Plan) is to further characterize potential environmental quality concerns and address identified data gaps regarding a portion of the United Technologies Corporation (UTC) property known as Rentschler Field. These potential environmental concerns and data gaps were outlined in "*Chapter 11, Rentschler Field, Environmental Conditions Summary*" (ECS), submitted as part of the "*Master Development Plan for Adriaen's Landing and Stadium at Rentschler Field*" submitted to the Connecticut Legislature on March 3, 2000. The location of Rentschler Field is shown on the U.S.G.S. 7.5-minute topographic map of East Hartford, CT (Figure 1). Figure 1 provides additional information including surface features within 1/4 mile of the facility, and surrounding land uses and existing structures.

The Rentschler Field property is comprised of approximately 600 acres and UTC has offered to transfer ownership of a 75-acre parcel of land (the "Stadium Parcel") to the State of Connecticut in satisfactory condition for development of a stadium under applicable environmental laws. The purpose of the property transfer is to allow for the construction of a football stadium to be utilized primarily by the University of Connecticut (UCONN) (the "Stadium Project") for football. The intent of this proposed characterization Work Plan is to gather additional site-specific environmental quality data from across the Stadium Parcel in an effort to fill data gaps, further define environmental conditions, and to provide a detailed evaluation of potential remedial efforts, should any be required. Specifically, Marin has been tasked to perform an evaluation of the following issues relative to the Stadium Project:

1) Further characterize surficial and subsurface soils and ground water;
2) Evaluate additional environmental quality data provided by UTC;
3) Compare site-specific analytical data to appropriate regulatory criteria;
4) Establish if the existing data, in combination with the data developed from the supplemental characterization (discussed herein), is sufficient to allow for the evaluation

2.0 SITE INVESTIGATION OBJECTIVES

The primary objectives of the Rentschler Field Soil and Ground Water Characterization Plan (Plan) include:

1) Collection of representative samples of soil and ground water from across the Stadium Project at locations that will provide a more comprehensive understanding of the environmental conditions at the Project; and

2) Assemblage of information for the development of a Remedial Action Plan (RAP), Soil Management Plan (SMP) and remedial cost estimate, should any of these items be required.

In order to meet these objectives, Marin has designed the Plan based on information presented in the "*Chapter 11, Rentschler Field, Environmental Conditions Summary*" (ECS), submitted as part of "*Master Development Plan for Adriaen's Landing and Stadium at Rentschler Field*" to the Connecticut Legislature on March 3, 2000. Specifically, Marin has considered the following information in the development of this Plan:

1) **Known Environmental Units:** Four Environmental Units have been identified and initially characterized at the site. These areas include, and are located relative to the proposed Stadium Project Area, as follows: the Former Silver Lane Pickle Company, to the northwest; the Former Army Barracks, center and west; the Northern Klondike Area, east, southeast; and the Northern Runway Area, the primary location of the Stadium Project. Figure 2 presents the locations of these Environmental Units.

2) **Existing Analytical Data:** In addition to the identification of the four Environmental Units, limited soil, ground water, and surface water analytical data are available for the site. These samples were collected by Loureiro Engineering Associates (LEA), on behalf of UTC.

Based on this information, Marin has identified the following specific objectives to be met in the performance of this Plan:

- Further delineate the horizontal and vertical extent of metals and Total Petroleum Hydrocarbons (TPH) detected in soils and ground water across the Stadium Parcel. This effort will include targeting areas where metals and TPH releases are suspected to have occurred as the result of historic filling and/or as identified by LEA analytical data.

- Characterize soils for the presence/absence of herbicides, pesticides, polychlorinated biphenyls (PCBs), and semi-volatile organic compounds (SVOCs) at locations within the Former Army Barracks, Northern Klondike and North Airport Runway Environmental Units.

- Perform a preliminary investigation of the ground water, in areas not previously characterized, through the installation of monitoring wells and ground water sampling and analyses.

- Characterize environmental conditions in areas specific to the construction phase and public usage areas of the Stadium Project (i.e., excavation, de-watering, parking, utilities).

3.0 STADIUM PARCEL DESCRIPTION

The following presents a summary of the Environmental Conditions Summary Report (ECS), submitted as part of the "*Master Development Plan for Adriaen's Landing and Stadium at Rentschler Field*" to the Connecticut Legislature on March 3, 2000.

3.1 *Stadium Parcel Location*

The Rentschler Field facility is located on an approximately 600-acre tract of land, of which, UTC will donate 75-acres to the State of Connecticut. The Stadium Parcel is relatively flat with few undulations. In general, the parcel is bounded on the east by wetlands, to the north by Silver Lane, to the northwest by Willow Brook, and to the west and south by lands to be retained by UTC (Figure 2).

3.2 *Geology and Hydrogeology*

3.2.1 Soils

The area of the Stadium Parcel is underlain by bedrock mapped as the Portland Arkose. The Portland Arkose consists predominantly of relatively fine grained red-brown to gray siltstones and shales, but grading to coarse-grained arkosic sandstone and conglomerate in stratified beds does exist. The depth to bedrock beneath the Stadium Parcel is thought to be greater the 100 feet below land surface. Actual depth to bedrock will be determined through an unrelated geotechnical investigation.

Overlying the bedrock, varved clays and silts (e.g., laminated sediments) are found beneath the Stadium Parcel at thicknesses of 70 to 110 feet and are indicated in the geologic literature to be thicker (perhaps as much as 300 feet thick) below adjoining areas to the southwest.

A layer of fine to coarse grained alluvial sand is found to overlie the varved clays and silts at the Stadium Parcel and is typically 10 to 15 feet thick, but is thicker (about 20 feet) at the northwest portion of the Stadium Parcel.

3) The area to the south of the Willow Brook has not been characterized. This area should be evaluated for potential impacts derived from the Former Silver Lane Pickle facility.

3.3.2 Northern Klondike Area

The North Klondike Area Environmental Unit is located in the southeast portion of the Stadium Parcel. Historically, it has been reported that the wetlands have been filled in and the area was then used for the staging and storage of equipment and materials. TPH was detected in soils above the GB PMC.

The Northern Klondike Area is bounded on the east by mapped wetlands, to the west by an intermittent stream and has been reportedly filled in. Accordingly, the applicability of the RSRs may change from surface water, to those of intermittent streams and wetlands. The current Project plan is to include this area for on-site supplemental grass parking. This area represents an alternate for on-site supplemental grass parking and will not be constructed if it proves not to be cost effective.

In summary, based upon Marin's review of the analytical data and comparison to the RSRs, as applied to the Northern Klondike Environmental Unit, the ECS identified the following data gaps:

1) Ground water flow direction may vary seasonally and much of the area is comprised of mapped wetlands. Based upon this information, Aquatic Life Criteria of the Water Quality Standards may be applicable to the ground water as it discharges to a surface water body. However, additional investigation is needed as well as an evaluation of the regulatory status of filled wetlands to determine compliance with the RSRs;

In summary, the ESC identified the following information and data gaps relative to the Northern Runway Environmental Unit:

1) LEA advanced thirty-nine GeoProbe soil borings to depths of four feet below ground surface within this Unit. Soil samples were collected for visual inspection and field instrument screening. Soil and ground water samples were not collected for laboratory analyses. Consequently, soil and ground water laboratory analytical data for this immediate area are not available for evaluation.

2) Perimeter monitoring wells in the vicinity of the Northern Airport Runway Environmental Unit are located as follows; just to the north of the runway area (NA-MW-01), to the west (Silver Lane Pickle Company) and to the southeast (Northern Klondike area). Ground water analytical results from these perimeter monitoring wells, as well as discrete ground water samples, have exhibited concentrations that may exceed the SWPC and/or Aquatic Life criteria for arsenic, cadmium, lead, and zinc; and

3) An evaluation of soil and ground water data should include a comparison to applicable RSR criteria as well as potential treatment, transportation and disposal requirements, should any be required. These data (e.g., ground water analytical) will be required in order to determine de-watering requirements for the excavation and construction activities associated with Stadium construction.

3.3.5 Potential Impacts To Stadium Development

In summary, the ECS identified several potential development issues relative to each Environmental Unit. These potential impacts to the development of the stadium may

4.0 SCOPE OF WORK

The objectives of this Plan are to collect representative samples of soil and ground water from the Stadium Project Areas at locations that will provide:

- Additional understanding of the environmental conditions in order to fill data gaps; and
- Initial characterization of the ground water quality beneath the Stadium Parcel, and in particular, within the footprint of the Stadium itself.

To assist in this evaluation, Marin proposes to advance sixty-six (66) soil borings and nine (9) test pit excavations as set forth in Section 5.0. In order to complement the three (3) existing monitoring wells, twelve (12) of the newly advanced soil borings will be converted to monitoring wells. Selected soil and ground water samples will be collected from across the Stadium Project area at specified locations as proposed within this Plan and analyzed by methods that will address the constituents-of-concern.

Initially, collected soil samples will be field screened with an on-site photoionization detector (PID). Selected soil and ground water samples will be forwarded to an off-site certified laboratory for the required analyses.

The detailed scope-of-work for the sampling activities includes:

1) Notification to utility companies and local agencies of the planned sampling activities and request for delineation of the underground utilities on site.

2) Collection of soil samples from specified locations

3) Collection of ground water samples from thirteen (13) monitoring well locations.

4) Proper placement of all selected samples into laboratory-supplied glassware and delivery to a State-certified laboratory for analyses.

5) Review of analytical results derived from the soil and ground water sampling events to determine areas of the site where constituents-of-concern are identified above criteria in the RSRs.

6) Provide OPM with a report containing documentation of all activities performed on site. This report will include:

- soil sample location plan;
- discussion of the analytical methods used and the results of all sample analyses presented in summary tabular form;
- soil boring logs;
- monitoring well completion diagrams;
- comparison of the analytical results to applicable RSR Criterion;
- discussion of all Quality Assurance and Quality Control (QA\QC) measurements completed during the soil and ground water characterization;
- conclusions and recommendations section; and
- Executive Summary

5.0 TECHNICAL APPROACH

5.1 *Field Activities*

5.1.1 Constituents-of-Concern

Based upon the historical activities associated with the Stadium Parcel, communications with CTDEP and review of the existing environmental data collected by LEA, on behalf of UTC, the constituents-of-concern have been identified by the following analytical parameters:

- Volatile Organic Compounds (VOCs);
- Semi-volatile Organic Compounds (SVOCs);
- Priority Pollutant (PP) Metals (Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, and Thallium);
- Pesticides and Herbicides;
- Polychlorinated Biphenyls (PCBs); and
- Total Petroleum Hydrocarbons (TPH).

The sample locations and location-specific analytical parameters have been selected to address these constituents-of-concern.

5.1.2 Soil and Ground Water Sample Locations

Several factors have been considered to determine the proposed sampling locations for the supplemental site characterization. These factors include: 1) historical information derived from aerial photographs; 2) field observations and current existing conditions at the site; 3) proposed archeological evaluations; 4) proposed Project usage areas (i.e., off-site grass parking); 5) communications with CTDEP, UTC and LEA; and 6) existing analytical data from previous investigations and remedial actions.

Table 1 provides a summary of the rationale used for the selection of the various soil and ground water sample locations as well as location-specific analytes. Figure 4 provides the locations of the proposed soil and ground water sampling points.

5.1.3 Analytical Methodologies

Table 2 presents the location-specific depths associated with the collection of soil samples as well as the analytical parameters for the aqueous and solid matrices.

Table 3 presents the list of analytes, respective laboratory methodologies, sample containers, required sample volumes, holding times and preservation requirements for soil and ground water samples.

5.1.4 Soil Sampling Methodologies

Three types of soil sample collection methodologies will be used during the implementation of this Plan: "direct-push"; hand-auger; and hollow-stem auger. Each of these methods are described below.

Direct-Push:

Soil sample cores will be collected at forty-three (43) locations identified on Figures 3 and 4 and Table 1. These samples will be collected using a "direct-push" system fitted with a dedicated disposable polyethylene liner. New liners will be installed into the sampling probe prior to each sample collection. It is anticipated that the depths of these borings will be advanced to approximately ten (10) feet below land surface (bls). Soil samples will be collected in a continuous manner. The sampling probe and down-hole tools will be decontaminated prior to the first use at the Parcel as well as between each

subsequent sample location. Detailed decontamination procedures are presented in Section 5.4.1.

Hand-Auger:

Additional soil samples will be collected from six (6) locations with a hand-auger from the various drainage swales located across the Parcel as identified on Figure 4 and Table 1. It is anticipated that the depths of these borings will be advanced to approximately two (2) feet bls. Soil samples will be collected in a continuous manner. Appendix A – Hand-auger Soil Collection, presents further details specific to this sampling methodology. The hand-auger unit will be decontaminated prior to the first use at the Parcel as well as between each subsequent sample location. Detailed decontamination procedures are presented in Section 5.4.1.

Hollow-Stem Auger:

Deeper soil samples will be collected from seventeen (17) locations, both within the Stadium footprint as well as the other monitoring well locations, with a hollow-stem auger drill rig as identified on Figure 4 and Table 1. It is anticipated that the depths of seven (7) soil borings, located within the Stadium footprint, will be advanced to approximately thirty (30) feet bls. The remaining ten (10) soil borings, dispersed across the Parcel, will be advanced to approximately fifteen (15) feet bls. Soil samples will be collected in a continuous manner. Appendix A – Split-spoon Soil Sampling, presents further details specific to this sampling methodology. The hollow-stem augers, split-spoons and all down-hole tools will be decontaminated prior to the first use at the Parcel as well as between each subsequent sample location. Detailed decontamination procedures are presented in Section 5.4.1.

Test Pit Excavations:

A series of nine (9) test pit excavations will be performed in the areas of the Former Army Barracks leach fields. Three of the former leach fields are located beneath grass, two are beneath the existing runway (Figure 4). Test pit trenches will be excavated with a backhoe as described in Appendix B. As leach field number 1, 2, and 3 are under grass, these will be advanced first. Attempts will be made to excavate test pits in the areas of leach field numbers 4 and 5; however, in the event that runway pavement materials (i.e., asphalt, concrete) are to thick to remove with a backhoe, these areas will be evaluated subsequent to runway removal. In the case of the latter, a supplemental letter report will be developed to detail this course of work. It is anticipated that soils removed during these activities will be returned to the excavation. Detailed decontamination procedures are presented in Section 5.4.1.

In addition to the collection of soil samples for chemical analyses, soil samples will be characterized for lithology by the on-site Marin geologist. The subsurface lithologic characterization will include, but may not necessarily be limited to; soil type(s), description of non-soil materials, identification of saturated or unsaturated conditions, field instrument measurements as well as the presence/absence of odor, vapors, discoloration and mottling.

If dedicated hand sampling equipment are used to transfer the collected soil sample from the sampling instrument to the sample container, then they will be discarded into an appropriate container as discussed in Section 5.5. If reusable hand sampling equipment are used, then the sampling instrument will be decontaminated as discussed in Section 5.4.1.

5.1.5 Soil Sample Screening

Initially, upon removal of the soil sample core from the sampling device, a photoionization detector (PID) will be used to screen the soil sample for the area of the core that exhibits the highest relative response. In the case of "direct-push" sampling, this will be accomplished by cutting a longitudinal line the length of the soil core liner, deep enough to expose the porous surface of the collected soil. For split-spoon sample collection, the spoon will be opened. In all cases, the probe of the PID will be moved slowly above the retrieved soil sample to record relative PID response levels. Following the PID screening procedure, the section of the collected soil sample that represents the most elevated PID response, or exhibits visual indications of a potential environmental impact (e.g., discoloration), will be retained for certified laboratory analyses. Appendix C contains PID Field Screening and Maintenance Procedures.

5.1.6 Soil Sample Collection

Selected soil samples will be retained for off-site, certified laboratory analyses. Soil samples retained for VOC analysis will be placed directly into the laboratory-supplied glassware. Following collection of the soil sample for VOCs, if required, the remaining soil contained within the sampling device (i.e., liner, auger, split-spoon) will be homogenized within a properly decontaminated stainless steel mixing bowl prior to placement in the laboratory-supplied glassware. This procedure is completed in order to minimize any potential bias of the soil sample caused by natural stratification of the constituents within the soil core.

The following homogenization procedure will be used for the collection of non-volatile soil samples:

1) place retrieved soil sample into a properly decontaminated stainless steel bowl or pan;

2) thoroughly mix the sample in the center of the stainless steel pan or bowl;
3) quarter the mixed soil;
4) mix the individual quarters;
5) recombine the quarters;
6) perform one final mix of the sample prior to placement in the laboratory-supplied glassware.

Table 3 presents the required containers, sample volumes, preservation techniques (if required), and respective holding times for the laboratory analyses.

5.1.7 Ground Water Monitoring Well Installation

Thirteen (13) pre-selected soil boring locations will be completed as monitoring wells as identified on Figure 4. The monitoring wells will be installed with a hollow-stem auger drill rig. The purpose of these monitoring wells is to provide an initial characterization of ground water quality as it migrates to, from and beneath the Stadium Parcel. All soil cuttings from the advancement of the boring(s) will be containerized as set forth in Section 5.5.

Monitoring wells located within the footprint of the Stadium will be used to provide an initial characterization of ground water quality for the purposes of environmental data and construction de-watering activities. Two different depths of monitoring wells will be installed in order to evaluate the water quality within the two aquifer units (i.e., sand and varved clay/silt units), shallow and deep. The three (3) newly installed deep monitoring wells will be constructed to a depth of approximately 30 feet bls with approximately 10 feet of two-inch diameter, 0.10 inch slotted, PVC well screen. The three (3) newly installed shallow monitoring wells will be constructed to a depth of approximately 15 feet bls with approximately 10 feet of two-inch diameter, 0.10 inch slotted, PVC well screen. It is likely, that due to the location of these monitoring wells within the Stadium footprint, they will be destroyed during the planned Stadium construction activities. The

seven (7) other newly installed monitoring wells, located across the Parcel, will be completed with ten (10) feet of two-inch diameter, 0.10 inch slotted, PVC well screen that will intercept the water table.

Above the top of the screened interval, for all monitoring wells constructed as part of this Plan, the remainder of the well, will be constructed of solid PVC riser. The borehole annulus will be filled with clean, fine sand to approximately three feet bls. The sand will be placed in a manner that will not cause bridging, and will be measured repeatedly by the driller to confirm that sand pack bridging has not occurred. Once the sand pack has been properly installed, the remaining annulus will be filled with approximately two feet of bentonite pellets that will be hydrated. The placement of the hydrated bentonite will impede the infiltration of surface water into the borehole and monitoring well. Appendix D presents additional specifics relative to monitoring well installation and construction.

After completion of the new monitoring well installations, the thirteen (13) monitoring wells on the Stadium Parcel will be surveyed by a Licensed Surveyor to determine vertical datum and horizontal control. The completion of the survey will allow for the collection of depth-to-water measurements that can be converted to relative ground water elevations. This in turn will allow for an evaluation of ground water flow direction(s) and gradients.

5.1.8 Monitoring Well Development

Upon completion of monitoring well construction, all newly installed monitoring wells will be developed. The purpose for the development of monitoring wells is to remove fine-grained sediments from the monitoring well. These fine-grained materials may have been placed into suspension as a result of the hollow-stem auger advancement. The development process removes the fine-grained materials as well as increases the hydraulic communication between the monitoring well and the adjacent saturated aquifer

formation. All development water will be containerized as discussed in Section 5.5. Appendix E contains details regarding monitoring well development methodology.

5.1.9 Ground Water Sampling

One round of ground water samples will be collected from the thirteen (13) newly installed and three (3) existing monitoring wells (NA-MW-01, NK-MW-06S, NK-MW-17S) using a low-flow sampling technique (i.e., bladder or submersible pump). All ground water samples will be analyzed for VOCs, SVOCs, PP 13 metals, pesticides, herbicides, PCBs, and TPH as indicated on Table 2.

Prior to ground water sampling, depth-to-water measurements will be collected from the thirteen (13) monitoring wells. These data will allow for the calculation of a particular monitoring well volume and will also allow for the subsequent development of a ground water contour map. Appendix F details the methodology for the collection of water level measurements. Ground water field parameters including temperature, specific conductance, turbidity and pH, will be collected during well evacuation (purging). Ground water field parameters will be monitored until they stabilize within 10 percent of each other during purging. This is completed in order to obtain a representative ground water sample. The temperature/pH/conductivity meter will be calibrated and maintained on a daily basis according to the manufacturer's instructions. Appendix G contains details regarding the purging of monitoring wells and ground water sample collection. The purge water will be containerized and staged on-site until receipt and evaluation of the ground water analytical results. At that time, disposal options will be evaluated based upon the analytical results.

Ground water samples will be collected in the following order and will be unfiltered:

1) VOCs;
2) SVOCs;

3) TPH;
4) Pesticides;
5) Herbicides;
6) PCBs; and
7) PP 13 metals.

VOC vials will be filled with as little disturbance of the water as possible, leaving no headspace. All other sample containers will then be filled in the sequence indicated above, leaving some headspace. All samples will be preserved, as required, placed within a cooler, and then cooled to 4^0 Celsius.

5.2 *Stream Staff Gauges*

As presented in the ECS, at this time it is unclear if areas of local discharge/recharge related to storm drainage swales, underdrains, and the effects of seasonal variations in precipitation, contribute to localized ground water gradient reversals. In order to evaluate potential gradient reversals, up to three (3) stream staff gauges will be installed at locations identified on Figure 4. The purpose for these gauges will be to evaluate potential interrelationship(s) between the ground water and surface water regimes. These gauges will be surveyed into the monitoring well network. Depth-to-water data from these gauges will be collected simultaneously with the monitoring wells.

5.3 *Chemical Data Quality Objectives*

The objectives of this Plan are to provide a further characterization and evaluation of the nature and extent of potential environmental impacts that may exist at the site as a result of:

1) former Army Barracks operations;
2) former Airport operations;
3) former operations of the current owner(s); and

4) potential off-site sources of impacts that may effect the Stadium Parcel and potentially impede future development of the Parcel.

Data Quality Objectives (DQOs) are developed to ensure that the data collected will be of sufficient quantity and quality for their intended uses. Data use is defined by the types of decisions made with the data, the required quantity and precision, and the methods by which data will be collected and analyzed. The objectives of this field investigation are to collect the data necessary to assess the presence/absence of potential contaminants in the areas identified above.

The analytical techniques to be used during the implementation of this Plan are described as being one of the following levels:

- Level I - field screening or analysis using portable instruments. Results are often not compound specific and not quantitative but results are available in real-time and are often used as a screening tool to select samples to be used with Level III analytical techniques.

- Level III - sample analyses performed in an offsite analytical laboratory using standard, documented procedures other than Contract Laboratory Program (CLP) protocols.

5.3.1 Characteristics of Data Quality

The precision, accuracy, completeness and comparability (PACC) parameters are the characteristics of data quality and are described below:

Precision is the mutual agreement among individual measurements of the same property and is a measure of the random error component of the data collection process. The overall precision of the data is the sum of that due to sampling and analysis. To determine the analytical precision of the method and/or laboratory analyst, a routine program of replicate analyses is performed. The results of the replicate analyses are used to calculate the

relative percent difference (RPD), which is the governing QC parameter for precision. For triplicate analyses, the relative standard deviation is reported.

Accuracy is the agreement between a measurement and the true value. It is a measure of the bias or systematic error of the entire data collection process. Sampling accuracy is assessed by evaluating the results of field and trip blanks. To determine the accuracy of an analytical method, a periodic program of laboratory control sample spiking is conducted. The results of sample spiking are used to calculate the quality control parameter for accuracy evaluation, the percent recovery (%R).

Completeness is the adequacy in quantity of valid measurements to prevent misinterpretation and to answer important questions.

Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusion.

5.3.2 Objectives for Precision, Accuracy, Completeness, and Comparability

The objectives for precision and accuracy for each chemical are based mainly on the capabilities of the approved SW-846 analytical methods with respect to laboratory performance. For the purposes of this investigation, field duplicate precision will be within a factor of 5 for both the soil and groundwater parameters. Since standard sampling procedures and analytical methods are being used, 100% completeness is expected for all Level III analytical techniques. In addition, the resulting data from the samples collected and analyzed using the Level III analytical techniques should be comparable with other data collected using like sampling and analytical methods under similar field conditions and same general locations.

5.4 *Quality Assurance / Quality Control (QA/QC)*

The overall QA objective for field activities, data analyses and laboratory analyses is to produce quality data to support evaluation of potential impacts to the environment and selection of remedial alternatives, if necessary. Specifically, all data will be gathered or developed using procedures appropriate for the intended use. Standard procedures will be used so that known and acceptable levels of accuracy are maintained for each data set.

Sampling quality assurance includes the collection of three types of quality control samples; equipment blanks, trip blanks and replicate samples. Quality control checks on field activities will be performed to assure collection of data that is representative and valid. The results of the quality control samples will be reported along with the sample analytical results.

5.4.1 Equipment Decontamination

Non-dedicated (e.g., reusable) equipment will be decontaminated upon initial mobilization to the site, between each successive use on-site and prior to final departure from the site. A small decontamination area will be staged next to each area to be characterized (i.e., boring location). The area will be covered with plastic sheeting of sufficient size to protect the ground surface. All decontamination materials and procedures will be temporarily staged and performed on the plastic sheeting. A larger, area, constructed with a berm, will be for the decontamination of the hollow-stem auger flights, backhoe bucket and other larger intrusive pieces of equipment. The decontamination procedures will be specific to the analytes of interest for a particular set of collected samples. For instance, if metals are the only analyte of interest for a sample, nitric acid will be used as an intermediate rinse, rather than methanol or acetone (as with VOCs).

The decontamination steps to be used for non-dedicated sampling equipment consist of the following steps:

Organic constituents:

1. Non-phosphate soap (Alconox® or equivalent) and tap water wash;
2. Tap water rinse;
3. Solvent rinse (e.g., 40% methanol);
4. Distilled/deionized water rinse; and
5. Allow to air dry.

Inorganic constituents:

1. Non-phosphate soap (Alconox® or equivalent) and tap water wash;
2. Nitric acid rinse;
3. Distilled/de-ionized water rinse; and
4. Allow to air dry.

In the event a particular sample, or samples are to be analyzed for organics and inorganics, the sampling instrument(s) will be decontaminated with a combination of the above procedures (i.e., combination of nitric acid followed by solvent rinse). Appendix H contains details regarding the decontamination of reusable equipment.

5.4.2 Field Blanks

The purpose of rinsate, or field blanks, is to determine whether the reusable sampling equipment has been properly decontaminated. If the equipment has not been properly decontaminated, this action may allow for the cross-contamination of samples collected with the same piece of equipment. Samples consist of laboratory-provided reagent water collected from a final rinse of sampling equipment after the decontamination procedure has been performed. For the purpose of this investigation, three (3) field blanks from the soil sampling event will be collected. One field blank sample will be collected during the ground water sampling event.

6.0 SAMPLE CUSTODY AND DOCUMENTATION

6.1 *Sample Custody*

The purpose of the sample custody procedures is to document sample history from the time of preparation of the sample containers through sample collection, shipment, and analyses. An item is considered to be in one's custody if:

- It is in the physical possession of the responsible party;
- It is in view of the responsible party;
- It is secured by the responsible party to prevent tampering; and/or
- It is secured by the responsible party in a restricted area.

6.1.1 Chain-of Custody

Completed chain-of-custody forms will be required for all samples requiring analyses. Chain-of-custody forms will be initiated in the field by the field team member(s) during sample collection events. One chain-of-custody form will be completed for each shipping container.

A completed chain-of-custody form will contain the following information:

- site name;
- sample's unique identification number;
- date and time of sample collection;
- number, size and type of containers;
- sample description;
- sample type;
- sample preservation (if any); and
- analyses required.

The original chain-of custody form will accompany the samples to the laboratory. Copies will be made prior to shipment (or multiple-copy forms used) for separate field documentation. Prior to shipment of samples, the chain-of-custody will be signed and dated by a member of the field team who has verified that those samples listed on the form are indeed being shipped. After packaging has been completed, custody seals signed and dated by the field team member, will be affixed to the cooler.

6.1.2 Sample Labeling and Numbering

Samples will be identified by affixing a pressure sensitive gummed numbered sample label on the container(s). Sample labels will be completed with indelible ink. A completed sample container label may include the following information:

- Sample type (e.g., soil, sediment, water);
- Project name;
- Project number;
- Sample location, including site name and sample interval, if applicable;
- Chemical analyses required (i.e.; analytical method number);
- Sample's unique identification number;
- Date and time of sample collection;
- Mode of collection (composite or grab); and
- Preservative added, if applicable.

All samples for chemical analyses, including QA samples and blanks, will be given a unique sample number. A set of three identification numbers will be used for each sample. The sample number will consist of the following:

- Site number - all samples will begin with the project number 581.

- Location identifier - A five digit code will be used to identify the location of each

sample location. The first two of the five digits will include the sample type, either ss (soil sample) gw (ground water sample), tb (trip blank), rs (replicate sample) or eb (equipment blank) followed by a three digit location identifier. For example, 581-SSCT9-XX would indicate soil sample location CT9; 581-TB001-XX would indicate trip blank 001, 581-RS001-XX would indicate replicate sample number 001 and 581-EB001-XX would indicate an equipment blank.

- Sample identifier - The third set of numbers will be used only for soil sample collection and will indicate sample collection depth. For example, 581-SSCT9-0.5-1 would indicate a sample collected from soil sample location CT9 at a depth of 0.5 feet to 1 foot. In the cases when the sample identifier is not used, these numbers will remain as zeros. For example 581-EB001-00 would indicate an equipment blank number 001.

6.1.3 Sample Handling, Packing and Shipping

Sample packaging and shipping procedures are presented below.

The shipment of all samples will be completed within waterproof, plastic ice chests or coolers only. The drain valves will be taped closed, both internally and externally. After filling out the pertinent information on the sample label, the sample is placed in the bottle, jar, or vial and the lid is screwed on. Sample bottles are enclosed in clear plastic bags through which sample labels are visible that are then sealed. Bottles are placed upright in the cooler in such a way that they will not touch one another during shipment. Additional inert packing material will be placed (more than halfway) to partially cover sample bottles. Zip-lock style bags of ice will be placed around, among, and on top of the sample bottles. If chemical ice is used, it will be placed in a plastic bag. The chain-of-custody record will be sealed in a waterproof plastic bag and taped with masking tape to the inside lid of the cooler.

To verify that the samples have been maintained at a temperature of 4°C, a temperature blank will be enclosed in each cooler. The temperature blank will be sample container filled with potable water, dated, and labeled as *COOLER TEMPERATURE INDICATOR.* The temperature of the blank will be taken and recorded on the chain-of-custody record immediately upon receipt at the laboratory, prior to inventory and refrigeration.

The cooler lid will be secured with tape. The cooler is double wrapped completely with strapping tape at a minimum of two locations and no labels will be covered. Signed custody seals will be affixed on the front right and back left corners of the sample cooler. Seals will be covered with wide, clear tape.

6.2 *Field Logs*

Field observations and other information pertinent to the collection of samples will be recorded in a bound field book. The field notebook will consist of a bound surveyor's-type notebook, with water resistant pages, which will contain an overall record of all activities performed at the site. The following guidelines will be followed when entering information into the logbook:

- All entries will be made legibly with indelible, dark blue or black ink;
- All times will be reported as military time;
- All pages in the log will be numbered consecutively, signed and dated;
- No blank pages or sections of pages will be allowed. If a page is not completely filled in, a line will be drawn through the blank portion and initialed by the person keeping the log;
- Errors will be corrected by drawing a single line through the error and initialing the change;
- At the end of each day, the log book will be signed and dated.

The field notebook will include, but not be limited to, the following information:

- Record at the start of each day, the date, time and weather;
- Note the people present throughout the day;
- Record Personal Protective Equipment levels and any changes made during the day;
- Note field instrument measurements and calibration;
- Record action taken, project progress and observations;
- Documentation of sample collection, including:
  - Project name and number;
  - Sample matrix;
  - Sample location;
  - Sample description;
  - Sample date and time;
  - Sample analysis requested;
  - Sample identification number (including QC samples);
  - Sample collection method;
  - Sample handling (e.g., filtering) and preservation;
  - Specific reading for site testing, sampling or field screening;
  - Samplers' name;
- Any deviation from the sampling plan shall be noted and explained; and
- Record any unusual incidents, problems and accidents.

Sample location shall be recorded in the form of a map or sketch, with reference points measured from existing permanent structures. Sample ID shall be designated directly on the figure. Marin will also prepare a boring log for each sampling location. The boring log will provide the sample location, depth of sample collection, a description of the retrieved soil sample, results of field screening, depth to water if encountered, and any notes on visual indications of impact(s) to the soil.

7.0 PROJECT DELIVERABLES

7.1 *Final Report*

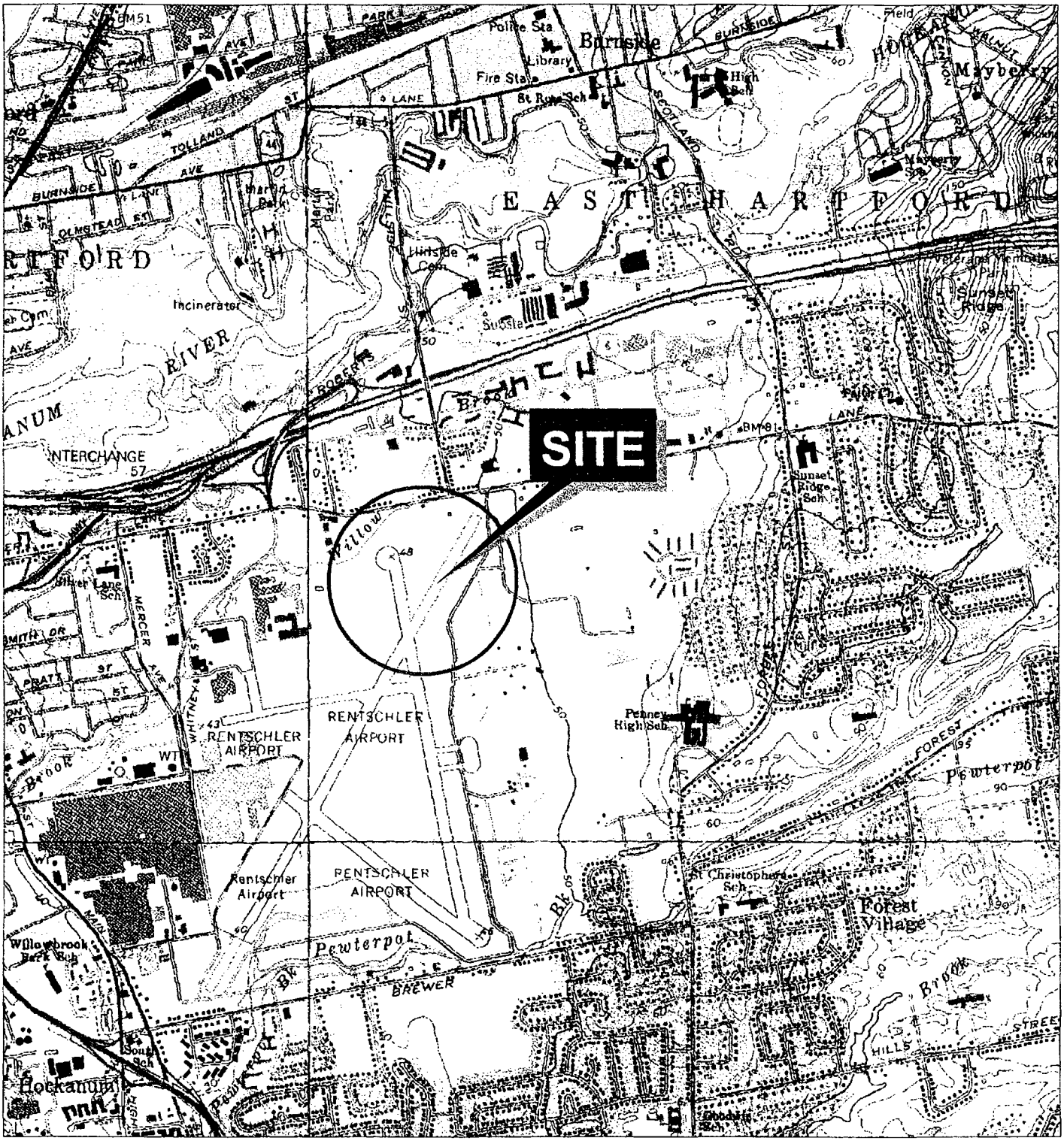
Upon completion of the work presented in this Plan, Marin will submit a report to the State of Connecticut, Office of Policy and Management that will detail the investigations performed at the Stadium Parcel and present our findings, conclusions and recommendations. The report will contain:

- soil sample location plan(s);
- discussion of the analytical methods used and the results of all sample analyses presented in summary tabular form;
- soil boring logs;
- monitoring well completion diagrams;
- comparison of the analytical results to applicable RSR Criterion;
- discussion of all Quality Assurance and Quality Control (QA\QC) measures completed during the soil and ground water characterization;
- conclusions and recommendations section; and
- Executive Summary

8.0 REFERENCES

Marin Environmental, Inc., "Chapter 11, Rentschler Field Environmental Conditions Summary", submitted to the Connecticut State Legislature, dated March 3, 2000.

Loureiro Engineering Associates, Inc., "Draft, Site Investigation and Remediation Report For The North Parcel Area Of The Airport/Klondike Area At Pratt & Whitney, East Hartford, Connecticut, Volumes I and II", dated May 4, 2000.



N
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MAP TAKEN FROM THE 7.5 MINUTE USGS TOPOGRAPHIC MAPS OF THE HARTFORD NORTH AND THE HARTFORD SOUTH QUADRANGLES, 1964, THE MANCHESTER QUADRANGLE, 1963, AND THE GLASTONBURY QUADRANGLE, 1964 (ALL PHOTOS REVISED 1992).

MARIN
ENVIRONMENTAL
7 ISLAND DOCK ROAD, HADDAM, CT 06438

FIGURE 1
SITE LOCATION MAP

RENTSCHLER FIELD
EAST HARTFORD, CONNECTICUT

MAY 2000 | FILE NO: 99-0581

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RCRA Document Management System
Image Target Sheet

RDMS Document ID # 100450

Facility Name: PRATT & WHITNEY MAIN STREET

Facility ID#: CTD990672081

Phase Classification: R-9

Purpose of Target Sheet:

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Description of Oversized Material, if applicable:

FIGURE 2: LOCATION OF ENVIRONMENTAL UNITS, OFF-SITE SUPPLEMENTAL GRASS PARKING

[X] **Map** [ ] **Photograph** [ ] **Other** (Specify Below)

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FIGURE 3: PROPOSED SOIL BEARING LOCATIONS, OFF-SITE SUPPLEMENTAL GRASS PARKING AREA

[X] **Map** [ ] **Photograph** [ ] **Other** (Specify Below)

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Purpose of Target Sheet:

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Description of Oversized Material, if applicable:

FIGURE 4: PROPOSED SOIL AND GROUND WATER SAMPLE LOCATIONS, PARCEL

[X] **Map** [ ] **Photograph** [ ] **Other** (Specify Below)

*** Please Contact the EPA New England RCRA Records Center to View This Document ***

TABLE 1

Proposed Sample Locations and Rationale
Rentschler Field

Monitoring Well Locations			
Location ID	Sample Location	Rationale	Collection
WB-1, WB-2, WB-3	Willow Brook Area	Evaluate ground water quality in the vicinity of Willow Brook	HSA, LF
WL-1, WL-2, WL-3	Wetland areas, intermittent streams	Evaluate groundwater quality in the vicinity of wetlands and local discharge/recharge points	HSA, LF
SFP-1, SFP-2, SFP-3, SFP-1D, SFP-2D, SFP-3D	Within Stadium Footprint	Evaluate groundwater quality in the vicinity of the stadium construction for potential discharge/treatment requirements	HSA, LF
MW-LF-1	Southwest portion of Stadium Project	Evaluate groundwater quality in the vicinity of a former leach field	HSA, LF

Soil Boring Locations			
Location ID	Sample Location	Rationale	
TP-LF-1, 2, 3, 4, 5, 6, 7, 8 and 9	Former Army Barracks Leach Fields	Evaluate soil quality in the vicinity of the five former Army Barracks Leach Fields within the Stadium Parcel	TP
SB-SFP-1, 2, 3, and 4	Within Stadium Footprint	Evaluate soil quality in the vicinity of the stadium construction for potential Soil Management Requirements	HSA
SB-NS-01 to 08	Spatially across the Stadium Parcel	Evaluate shallow soil quality across the Stadium Parcel for potential Soil Management Requirements	DP
SB-CT-1, 2, 3, 4, 5, 6, 7, 8, and 9	Spatially across the Stadium Parcel	Evaluate soil quality across the Stadium Parcel for potential Soil Management Requirements	DP
ARC-1, 2, 3, 4, 5 and 6	Within the proposed Archaeological Excavations	Evaluate soil quality in the vicinity of the Archaeological Excavations and Stadium Parcel for potential Health and Safety Requirements	DP
SB-DS-1, 2, 3, 4, 5 and 6	Drainage System	Evaluate soil quality in the vicinity of the various drainage systems across the Parcel	HA
SB-GP-1 through 20	Off-Site Grass Parking	Evaluate shallow soil quality in the vicinity of the off-site grass parking area	DP

Notes: LF – Low-flow ground water sampling, 10 newly and 3 existing monitoring wells.
HSA – Hollow-stem and split-spoon soil sampling from 14 locations.
DP – "Direct-push" soil sampling from 29 locations.
HA – Hand-auger soil sampling from 6 locations.
TP – Test Pit Trench Excavations.

TABLE 2

Proposed Sample Depths and Analyses
Rentschler Field

Monitoring Well Locations			
Location ID	Sample Location	Depths [2]	Aqueous Analyses [3]
WB-1, WB-2, WB-3 [1]	Willow Brook	Monitoring well constructed to intersect water table	TPH, VOCs, SVOCs, metals, pesticides & herbicides, PCBs,
WL-1, WL-2, WL-3 [1]	Wetland areas, intermittent streams	Monitoring well constructed to intersect water table	TPH, VOCs, SVOCs, metals, pesticides & herbicides, PCBs,
SFP-1, SFP-2, SFP-3 [1]	Within Stadium Footprint	Monitoring wells to a depth of approximately 15 feet	TPH, VOCs, SVOCs, metals, pesticides & herbicides, PCBs,
SFP-1D, SFP-2D, SFP-3D [1]	Within Stadium Footprint	Monitoring wells to a depth of approximately 30 feet	TPH, VOCs, SVOCs, metals, pesticides & herbicides, PCBs,
MW-LF-1 [1]	Western area of Stadium Project	Monitoring well constructed to intersect water table	TPH, VOCs, SVOCs, metals, pesticides & herbicides, PCBs,

Soil Boring Locations			
Location ID	Sample Location	Depths [2]	Soil Analyses [4]
TP-LF-1, 2, 3, 4, 5, 6, 7, 8, 9	Former Army Barracks Leach Fields	Collect soil samples at 4-6 bls, retain 6-8 feet bls	TPH, VOCs, metals, pesticides & herbicides
SB-SFP-1, 2, 3, and 4	Within Stadium Footprint	One sample per each ten foot interval per boring to 30'	TPH, VOCs, metals, pesticides & herbicides
SB-NS-01 to 08	Spatially across the Stadium Parcel	One sample PID based and/or visual observation to 2'	TPH, VOCs, metals, PCBs pesticides & herbicides
SB-CT-1, 2, 3, 4, 5, 6, 7, 8, 9	Spatially across the Stadium Parcel	Two samples PID based and/or visual observation to 10'	0-2' same as SB-NS locations, PCBs to depth of 10'
ARC-1, 2, 3, 4, 5 and 6	Within Archaeological Excavations	Collect soil samples at 0-2 bls, retain 2 to 4 bls	TPH, VOCs, metals, PCBs pesticides & herbicides
WL-1, WL-2, WL-3 [1]	Wetland areas, intermittent streams	One sample PID based and/or visual observation to 15'	TPH, VOCs, metals, pesticides, herbicides, PCBs
SFP-1D, SFP-2D, SFP-3D [1]	Within Stadium Footprint	One sample each ten foot interval per boring to 30'	TPH, VOCs, metals, pesticides & herbicides
MW-LF-1 [1]	Western area of Stadium Project	One sample based on PID and/or visual observation t 15'	TPH, VOCs, metals, pesticides, herbicides, PCBs
SB-DS-1, 2, 3, 4, 5 and 6	Drainage System	Collect soil samples at 0-2 bls, retain 2 to 4 bls	SVOCs, pesticides, herbicides, PCBs
SB-GP-1 through 20	Off-Site Grass Parking	One sample PID based and/or visual observation to 10'	TPH, VOCs, metals, pesticides & herbicides, PCBs

Notes: bls - Below Land Surface.
TPH – Total Petroleum Hydrocarbons.
VOCs - Volatile Organic Compounds.
SVOCs – Semi-volatile Organic Compounds
Metals – Priority Pollutant Metals by Mass Analyses, soil samples to be retained for potential SPLP or TCLP analyses.
Priority Pollutant Metals include; Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, and Thallium.
[1]: Monitoring wells to be installed at respective soil boring locations.
[2]: All soil borings to be advanced to a minimum of approximately 10 feet bls.
[3]: Three existing monitoring wells to be analyzed for the same aqueous analyses as listed above.
[4]: Pesticides & Herbicides to be collected at 0-2 bls.

TABLE 3

Required Containers, Sample Volumes, Preservation Techniques, and Holding Times For Certified Laboratory Analyses

Rentschler Field

Analyte	Analytical Method	Container	Min. Volume	Preservation	Maximum Holding Time
Soils					
VOCs	8260B	Glass w/teflon lined septum	4 oz	cool, 4°C	14 days
SVOCs	8270C	Glass, wide mouth, teflon lined cap	8 oz	cool, 4°C	7/40[1] days
PP 13 Metals [2]	6010	Glass, wide mouth, teflon lined cap	4 oz	cool, 4°C	6 months [3]
PCBs	8082	Glass, wide mouth, teflon lined cap	4 oz	cool, 4°C	7/40[1] days
TPH	CT DEP ETPH	Glass, wide mouth, teflon lined cap	4 oz	cool, 4°C	7/40[1] days
Pesticides, Herbicides	8081/8151	Glass, wide mouth, teflon lined cap	4 oz	cool, 4°C	7/40[1] days
Ground Water					
VOCs	8260B	Glass w/teflon lined septum	(2) 40 ml	HCL, pH<2, cool, 4°C	14 days
SVOCs	8270C	Amber glass, teflon lined cap	2 liters	cool, 4°C	7/40[1] days
PP 13 Metals [2]	6010	Plastic	500 ml	HNO_3, pH<2, cool, 4°C	6 months [3]
PCBs	8082	Amber glass, teflon lined cap	2 liters	cool, 4°C	7/40[1] days
TPH	CT DEP ETPH	Amber glass, teflon lined cap	2 liters	H_2SO_4, pH<2, cool, 4°C	7/40[1] days
Pesticides, Herbicides	8081/8151	Amber glass, teflon lined cap	1 liter	cool, 4°C	7/40[1] days

Notes:

(1) - Extraction within 7 days, analyses within 40 days.

(2) - PP 13 Metals refers to the 13 Priority Pollutant Metals and include; Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, and Thallium.

(3) - Holding time for mercury is 28 days, all other metals 180 days.

ATTACHMENT A-2 (TO APPENDIX A)

DESCRIPTION OF STANDARD PENETRATION TEST (SPT)

ATTACHMENT A-1 (TO APPENDIX A)

SUBSURFACE LOG

The test is relatively simple and almost all U.S. exploration drilling rigs are equipped to perform it. The test uses a 140 pound weight falling freely for a distance of 30 inches to drive a 2.0-inch outside diameter by 1-inch inside diameter split barrel sampler (split spoon) into the soil in the boring. The sampler is typically about 30 inches in length, although other lengths are permitted by ASTM. The blow counts required to drive the sampler are counted and recorded for each 6-inch increment of spoon advancement. The spoon is driven at least 18 inches unless refusal is encountered. Refusal is defined by ASTM as one of three occurrences:

- A total of 50 blows has been applied during any of the 6-inch increments;
- A total of 100 blows has been applied;
- There is no observed advance of the sampler during the application of 10 successive blows.

The definition of refusal is often used as a basis for evaluating the depth to hardpan or sound bedrock during investigations.

The blowcounts obtained during performance of the SPT are summarized by the SPT N-value. The SPT N-value is defined as the sum of the blowcounts required to drive the sampler during the second and third 6-inch increments. The blowcounts for the first 6-inches are not used as it is assumed that the drilling process has disturbed that zone. Correction factors may be applied to the N-values based on the grain sizes of the soil or sample depth.

DESCRIPTION OF STANDARD PENETRATION TEST (SPT)

I. Description of Standard Penetration Test (SPT)

The Standard Penetration Test (SPT) is a common soil and weak rock investigation technique that is used world-wide. The current standard method for the North American use of the SPT is described in ASTM D1586. The test is widely used in geotechnical and hydrogeological studies in many geological environments.

The concept of a standard penetration resistance was first introduced in North America in 1927 and was used extensively by the Raymond Concrete Pile Company. Over the next two decades, several variants of the penetration test were used with different sampler sizes and hammer configurations. Terzaghi and Peck's landmark 1948 textbook "Soil Mechanics in Engineering Practice" and U.S. Army Corps of Engineers's research focused on the current SPT configuration as the preferred system. Further research in the 1950s resulted in the assignment of relative density percentages to specific ranges of SPT N-values. The SPT test, essentially in its present form, was first codified by ASTM in 1958 as Standard Method Designation D1586.

Since ASTM and other standards organization codified the SPT, extensive research, predominantly in North America, Britain, and Japan, has provided useful correlations for using the SPT N-values in evaluating the relative density of sands. This information can then be used for evaluating settlement and strength characteristics of the in-situ soils. The major uses of the SPT has been for foundation design and for evaluating liquefaction potential of sand deposits. Clay shear strengths have also been correlated to the SPT N-values. Since the clay shear strength is a function of the clay moisture content which is in turn related to its consolidation history, and since the sand relative density is also a function of its consolidation history, the SPT can be used to aid in evaluating the general consolidation history of a soil deposit and therefore, can help in determining its geologic history. Since permeability is a function of soil density, data on the soil density can also be used to aid in correlating permeability of different zones of a soil deposit.

IV. Equipment Cleaning

Equipment cleaning will be performed at the beginning of the sampling event and between each separate sampling location as described in Appendix H.

Procedures

Soil samples will be taken to provide a continuous profile of the subsurface. A geologist will be on-site during the drilling operations to fully describe each soil sample including: 1) soil type; 2) color; 3) recovery; 4) relative moisture content; 5) texture; 6) grain size and shape; 7) consistency; and 8) any other noteworthy observations. The descriptions will be recorded on a project dedicated bound field book or project log (Attachment A-1).

Upon retrieval of split-spoon samples, representative portions of the bottom 1.5-foot depth increment from each sample (unless modified by site-specific conditions), will be placed in appropriate sample containers. One representative portion of each sample will be placed in a clean jar (or Ziploc-style bag), covered with aluminum foil, and let stand for several minutes. If Ziploc-style bag is used, the bag will be sealed. The head space will then be screened with a photoionization detector (PID) or equivalent field instrument and the relative concentration of total volatile organic compounds (VOCs) in the sample will be recorded on the boring log.

Sample containers will be labeled, temporarily stored on-site in coolers with ice, and transported to the appropriate testing laboratory. The samples will be handled, packed, and shipped in accordance with the procedures set forth in Section 6.

The supervising geologist will be responsible for documenting drilling events in the field notebook. The drilling contractor will be responsible for obtaining accurate and representative samples; informing the supervising geologist of changes in drilling pressure and loss of circulation (when using drilling fluids); and keeping a separate subsurface log of soils encountered, including blow counts [i.e., the number of blows from a soil sampling drive weight (140 pounds) required to drive the split-spoon sampler in 6-inch increments] as described in Attachment A-2.

III. Survey

A field survey control program will be conducted using standard instrument survey techniques to document the boring sampling location and elevation.

Plan.

8. Repeat as necessary to the appropriate depth.

II. Hollow-Stem Auger Soil Boring Sampling

Introduction

Soil borings will be completed using the hollow-stem auger drilling method to a depth specified by the supervising geologist/engineer. In situations where physical site features limit the use of drill rigs, soil borings will be completed with a hand driven auger, a portable power auger, or a tripod and split-barrel sampler (split-spoon) depending on the required depth and subsurface material.

The hollow-stem auger drilling technique, involving the use of a truck-mounted drill rig capable of rotating a string of hollow auger flights, will be used if possible. Drill cuttings are continuously lifted to the surface on the outside of the flights. If necessary, drill rods and a plug are used inside the hollow-stem flights to keep out the soil. The plug is removed for split barrel (split-spoon) core sampling of soil beneath the end of the lead auger.

Samples of subsurface material encountered during the drilling of soil borings will be collected continuously to the required depth of the boring, or as directed by the supervising geologist. The sampling method employed will be American Society of Testing and Materials (ASTM) D1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

Materials

The following materials, as required, shall be available during soil boring sampling:

- Personal protective equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Appendix H);
- All drilling equipment required by ASTM D-1586;
- Appropriate sample containers and forms;
- Insulated coolers with ice;
- Field notebook;
- Photoionization detector; and
- Stainless steel spatula.

SOIL SAMPLING PROCEDURES

I. Hand Auger Sampling

Introduction

The drainage swale locations will be characterized by soil borings performed with a stainless steel hand auger. Samples of subsurface material encountered during this operation will be collected continuously to a maximum depth of two feet.

Materials

The following materials, as required, will be available during soil sampling:

- Personal protective equipment as required by the Health and Safety Plan
- Cleaning equipment (as required in Appendix H);
- Aluminum or stainless steel tray;
- Field notebook;
- Appropriate sample containers and forms;
- Insulated coolers with ice;
- Stainless steel bucket auger; and
- Spatula or knife.

Procedures

The following procedures will be employed to collect soil samples:

1. Put on personal protective equipment (as required by the Health and Safety Plan).
2. Drive a precleaned stainless steel bucket auger with a straight, vertical entry into the soil, to secure a reasonably representative sample.
3. Remove the auger and place on an aluminum or stainless steel tray.
4. To avoid cross contamination over the sample depth, with a precleaned spatula or knife remove all excess soil from the outside of the auger and place soil sample into tray or bowl.
5. Place the sample in the appropriate sample jar.
6. Record all appropriate information in the field notebook.
7. Label, handle, pack, and ship the samples in accordance with Section 6.0 of the Work

APPENDIX A

SOIL SAMPLING PROCEDURES

APPENDIX B

TEST PIT EXCAVATION PROCEDURES

Introduction

To insure a standard procedure for the documentation of subsurface conditions encountered during test pit excavations.

The following procedure details a method for conducting and recording subsurface conditions in test pits during site contamination, hydrogeological, and geotechnical investigations. A standard procedure for photographic samples and excavations is also included.

Safety Considerations

Test pit excavations are used to evaluate subsurface conditions of soils, groundwater and buried materials during certain types of field investigations. Since they are normally excavated using heavy equipment (backhoe, Gradall, etc.) and result in a deep pit in the ground, the following safety rules will be applied.

1. All buried utilities will be cleared by calling and scheduling at least 48 hours in advance the local "Dig Safe" service. Also, Marin will confirm clearance of utilities by contacting the property owner and those people most familiar with the site. At the discretion of the Marin project manager, Marin will use its cable location tool to verify the presence or absence of buried utilities.
2. The backhoe operator will take directions directly from the Marin supervisor. Hand signals will be used to communicate instructions mainly because background noise is often very loud.
3. No one will be allowed to enter a test pit greater than three feet in depth.
4. All spoils removed will be placed far enough away from the sides of the pit to prevent slumping into the pit.
5. Test pits will be terminated either at refusal, at the water table or if a buried utility line is uncovered.
6. In no case will an open excavation be left unattended. After logging the soil borings the test pit will be immediately backfilled.

7. During all excavation work, the supervisor will make all attempts to stand in front of the operator and away from the bucket arm.

Logging of soils

Vertical measurements in the excavation shall be made from the top of the test pit at a spot representative of the original grade. If ground water levels are to be measured over time, a reference point (wooden stake, nail, etc.) shall be established at the original grade. If the test pit is to be surveyed after backfilling, a flagged stake shall be established at the pit on ground representative of the original grade.

A fresh exposure of soil is made at the side of the pit (preferably facing the sun) in an area most representative of the overall soil profile. This exposure is made by having the backhoe take a smooth clean scraping off the entire side wall.

The soil profile log is recorded in the field notebook. Each test pit log shall be preceded by the following general information.

- Date
- Client, and Marin project number
- Location of project site
- Weather conditions
- Excavator type
- Time excavation started
- Test pit ID number and specific location
- Person logging pit

The soil profile is logged from the top down starting with the "A" horizon (top soil). A metal or fiberglass tape or surveyor's stadiarod should be used to measure all the soil horizons. The description of each horizon shall include the following information:

- Textural description of grains (i.e., fine to medium). This is used mostly when describing sands and gravels.

- The predominant grain size (clay, silt, sand or gravel).
- The secondary grain size using the proportions "trace" (0 – 10 percent), "little" (10 – 20 percent), "some" (20 – 35 percent), and "and" (35 – 50 percent).
- The relative density and consistency of the soil using the descriptions for cohesionless soils (sands and gravels) of very loose, loose, medium, dense and very dense. For cohesive soils (silts and clays), the consistency descriptions of very soft, soft, medium, stiff, very stiff, and hard shall be used.
- The moisture content of the soil using the relative descriptions dry, damp, wet and saturated. A saturated soil will yield free water when squeezed.
- Soil structure (i.e. blocky, granular, prismatic), if no structure is evident, make a note of it.
- Note the presence of absence of any mottling and the depth at which it starts and ends.
- Record the depth of seepage into the pit.
- Record the total depth of the pit and note if this was a refusal point where further excavation was limited by rock, concrete or other tough surfaces.
- Describe any bedrock encountered in the excavation.

The above listed requirements for a test pit log are considered as a minimum. Any additional observations that are pertinent to the interpretation of the subsurface conditions should be recorded. Certain projects may require that specific data be recorded. Certain projects may require that specific data analysis be conducted in the test pit. These requirements shall be detailed in the site sampling plan and presented to the field personnel, in writing, prior to the commencement of the field operations.

Photographing Test Pit Excavations and Samples

Whenever possible, the subsurface conditions shall be documented with a photograph. Photographs should be taken with a 35mm camera with standard film or digital camera. The field personnel taking photographs shall log all photos in the field notebook.

Photographs of test pits should be taken in good light, preferably during mid-day when the sun is high. A flash attachment should be made available if ambient light is too weak. The photo should be taken of the side of the pit most exposed to sunlight. Prior to taking the photo, some sort of identification must be placed in the photo. This is best done by writing the test pit ID in bold letters on a clipboard and placing it within the field of view of the camera. Other forms of identification can be used (i.e., building in background, etc.) but must be documented in the test pit log. In all photos, an object must be placed in the photo for scale. A scale is particularly useful in close-up photos.

APPENDIX C

PHOTOIONIZATION DETECTOR (PID) FIELD SCREENING

PHOTOIONIZATION DETECTOR (PID) FIELD SCREENING

I. Introduction

Field screening with a photoionization detector (PID) is a procedure to measure relative concentrations of volatile organic compounds (VOCs) and other compounds. The characteristics of the PID are presented in Attachment C-1; the compounds which it can detect are presented in Attachment C-2. Field screening will be conducted on the following:

- Work area air to assess exposure to on-site workers of air contaminants via the air pathway;
- Well headspaces as a precautionary measure each time the well cover is opened; and
- Headspace of soil samples to assess the relative concentration of volatile organics in the sample.

II. Materials

The following materials, as required, shall be available while performing PID field screening:

- Personal protective equipment (as required by the Health and Safety Plan);
- PID and operating manual;
- Calibration canisters for PID;
- Sample jars;
- Aluminum foil; and
- Field notebook or project log

III. PID Calibration

PID field instruments will be calibrated and operated to yield "total organic vapor" in ppm (v/v) as benzene (Attachment C-3). PID operation maintenance and calibration shall be performed in accordance with the manufacturer's instructions and entered on the PID calibration and maintenance log (Attachment C-4). Table C-1 presents calibration frequency and preventive maintenance information.

IV. Work Area Air Monitoring Procedures

1. Measure and record the background PID reading.
2. Measure and record breathing space reading.

V. Well Headspace Screening Procedure

1. Measure and record the background PID reading.
2. Unlock and open the well cover while standing upwind of the well.
3. Remove the well cap.
4. Place the PID probe approximately 6 inches above the top of the casing.
5. If the PID reading is less than 1 PID unit above background, proceed.
6. If the PID reading is more than 1 PID unit above background, move upwind from the well for 10 minutes to allow the well headspace volatiles to dissipate.
7. Repeat air sampling. If 1 PID unit above background is sustained for 5 minutes, do not gauge well
8. Record all readings.

VI. Sample Headspace Screening Procedure

Soil samples will be field screened with the PID upon collection for a relative measure of the total volatile organic concentration. PID readings will be recorded in the field notebook or the boring logs, whichever is appropriate.

1. Half-fill one clean glass jar with the sample (if sufficient quantities of soil are available) to be analyzed. Quickly cover the open top with one or two sheets of clean aluminum foil and subsequently apply screw cap to tightly seal the jar. Sixteen ounce (16 oz.) (approximately 500 mil) soil or "mason" type jars are preferred; jars less than eight ounces (approximately 250 ml) total capacity may not be used. In lieu of jars, plastic Ziploc-style bags may also be used.
2. Allow headspace development for at least ten minutes. Vigorously shake jars for 15

seconds both at the beginning and end of the headspace development period. Where ambient temperatures are below 32°F (0°C), headspace development should be within a heated area;

3. Subsequent to headspace development, remove screw lip to expose the foil seal. Quickly puncture foil seal with instrument sampling probe, to a point about one-half of the headspace depth. Exercise care to avoid contact with water droplets or soil particulates; As an alternative, syringe withdrawal of a headspace sample with subsequent injection to an instrument probe or septum-fitted inlet is acceptable contingent upon verification of methodology accuracy using a test gas standard;

4. Following probe insertion through foil seal and/or sample injection to probe, record the highest meter response for each sample as the jar headspace concentration. Using the foil seal/probe insertion method, maximum response should occur between two and five seconds. Erratic meter response may occur at high organic vapor concentrations or conditions of elevated headspace moisture, in which case headspace data should be recorded and erratic meter response noted.

VII. Equipment Cleaning

After each use, the readout unit should be wiped down with a clean cloth or paper towel.

The UV light source window and ionization chamber should be cleaned following the manufacturer's instructions once a month.

ATTACHMENT C-1 (TO APPENDIX C)

CHARACTERISTICS OF THE PHOTOIONIZATION DETECTOR (PID)

2020 Photoionization Air Monitor

User's Manual

PE PHOTOVAC

Detailed Operation

General Information

2020 must be calibrated in order to display concentration in ppm or mg/m³ units equivalent to the calibration gas. First, a supply of zero air which contains no ionizable gases or vapors, is used to set 2020's zero point. Then, calibration gas, containing a known concentration of a photoionizable gas or vapor, is used to set the sensitivity.

Occasionally clean ambient air will be suitable as zero air. Due to 2020's sensitivity, outdoor air is usually unsuitable for calibration. For best results, use a commercial source of zero grade air and a second regulator. Zero air should have not more than 0.1 ppm total hydrocarbons (THC).

If compound threshold limit values (TLVs) are exceeded, you should use a gas bag for sampling and calibration.

To determine the TLV of the compounds contained in the calibration gas, refer to the Material Safety Data Sheet (MSDS) supplied with your calibration gas cylinder.

If you will be using a gas bag for calibration, you should obtain the calibration kit (Part No. 390033). The calibration kit contains a regulator, a gas sampling bag and a gas bag adapter. See 3.3 for details of calibration using a gas bag.

Note: Disconnect 2020 from the AC adapter before beginning calibration.

3.2. Calibration Using the Flow-Match Regulator

3.2.1. Connecting the Flow-Match Regulator to the Cylinder

Warning: Observe proper handling procedure for all gases! See Section 1.2.2.

1. Connect the regulator to the calibration gas cylinder.

   If you are using a portable tank of calibration gas (Part No. 350012), connect the regulator (Part No. 350006) directly to the tank.

2. When the regulator is connected properly, you can read the cylinder contents from the regulator gauge.

3. Connect the adapter tubing to the regulator.

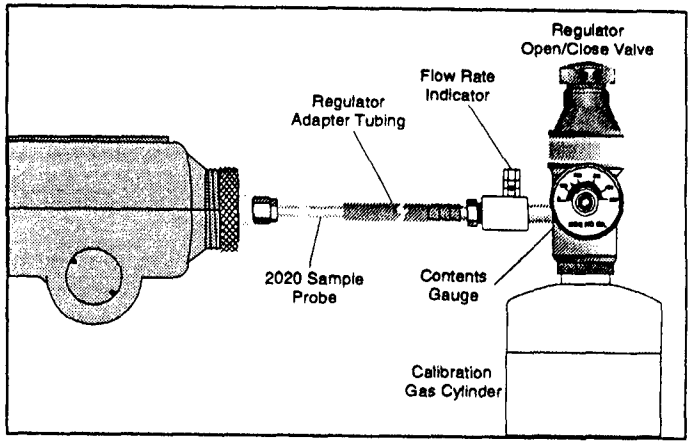

Figure 11 Flow-Match Regulator

3.2.2. Calibrating 2020 with the Flow-Match Regulator

1. Ensure the short sample probe is connected to the 2020 inlet. If you are using the long probe for sampling, then ensure the long probe is connected to 2020.

Note: Ensure the sample probe is free of any contamination as this will effect the calibration

2. Press the ENTER key.
3. Select "Set", "Cal" and then "Mem".
4. Select the desired Cal Memory. 2020 has 15 Cal Memories and can be calibrated with 15 different span gases or response factors if required. Only one Cal Memory can be used at a time. Each Cal Memory stores a different response factor, zero point, sensitivity, and alarm levels.
5. Select "Chng" and then "User". Enter a name for the calibration memory.

Press the ENTER key and enter a response factor (RF). Refer to Appendix 8.7 for a list of Response Factors. If the compound is not listed in Appendix 8.7 or you are measuring gas mixtures, then enter a value of 1.0. The concentration detected by 2020 will be multiplied by the response factor before it is displayed and logged.

6. Press the ENTER key and enter an alarm level for STEL, TWA and PEAK.
7. Press ENTER and expose 2020 to a supply of zero air.
8. Select "Set", "Cal" and "Zero". Allow 2020 to set its zero point.
9. Select "Set", "Cal" and "Span". 2020 asks for the span gas concentration. Enter the known span gas concentration, without pressing the ENTER key to confirm it.
10. Insert the 2020 sample probe into the adapter tubing from the regulator. See Figure 11.
11. Ensure the calibration gas cylinder is upright and open the regulator by turning the valve counterclockwise. Open the regulator until the ball is 1/8" from its rest position.

Note: Do not set the flow rate too high.

12. Press the ENTER key. 2020 sets its sensitivity.
13. When the display reverts to the default display, 2020 is calibrated and ready for use.
14. Remove the adapter tubing from the inlet and close the regulator.

If you turn off 2020 in the middle of zeroing or spanning, the next time you turn it on it will display a Cal status. This indicates that you need to calibrate 2020.

Note: While the Cal status is active, all alarms are deactivated.

3.3. Calibration Using a Gas Bag

3.3.1. Preparing the Calibration Gas Bag and the Zero Air Bag

Use the calibration kit (Part No. 390033) as follows:

Warning: Observe proper handling techniques for all gases! See Section 1.2.2.

1. Connect the regulator to the calibration gas cylinder.

   If you are using a portable tank of calibration gas, connect the regulator (Part No. 600649) directly to the tank.

   If you are using a large cylinder of calibration gas, you must obtain a high purity regulator as specified in Section 1.4. Isobutylene in air is usually supplied with a standard CGA 590 cylinder valve outlet. Obtain a regulator with the matching fitting. Connect the regulator to the tank of calibration gas. Tighten the regulator onto the tank with a wrench. Do not over-tighten.

Note: Do not force the connection.

Do not use Teflon tape with CGA fittings. In general, these fittings are designed for metal to metal sealing.

Do not use adapters to connect one CGA fitting to another type of CGA fitting. If the regulator does not match the outlet on your calibration tank, contact your specialty gas supplier.

2. Attach the knurled nut on the gas bag adapter to the regulator. Finger-tighten the fitting.

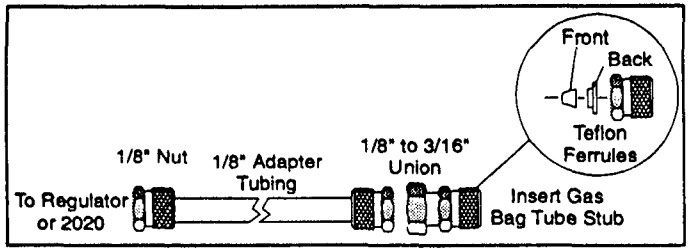

Figure 12 Gas Bag Adapter

3. Loosen the knurled nut on the reducing union of the gas bag adapter.

Note: Do not remove the nut from the union as the Teflon ferrules contained inside the nut may be lost. See Figure 12.

4. Insert the tube stub from the gas bag into the knurled nut. Tighten the knurled nut and ensure the tube stub is secure. If the gas bag is not secure, ensure you have inserted the tube stub far enough into the knurled nut. Do not over-tighten the fitting.

Note: Over-tightening the Teflon ferrules will result in damage to the ferrules!

5. The union should be connected to the gas bag adapter. If it is not, then tighten the nut on the adapter tube to the union.
6. Flush and fill the gas bag. See Appendix 8.6 for instructions.
7. Remove the knurled nut on the adapter tube from the regulator.
8. Repeat this procedure, if necessary, to prepare a bag of zero air.

Note: Do not use the same gas bag or gas bag adapter for the bag of zero air. You will contaminate the bag of zero air.

3.3.2. Calibrating 2020 with a Gas Bag

1. Disconnect the probe from the 2020.
2. Press the ENTER key.
3. Select "Set", "Cal" and then "Mem".
4. Select the desired Cal Memory. 2020 has 15 Cal Memories and can be calibrated with 15 different span gases or response factors if required. Only one Cal Memory can be used at a time. Each Cal Memory stores a different response factor, zero point, sensitivity, and alarm levels.
5. Select "Chng" and then "User". Enter a name for the calibration memory.
6. Press the ENTER key and enter a response factor.
7. Press the ENTER key and enter an alarm level for each mode.
8. Press the ENTER key and enter a response factor. Refer to Appendix 8.7 for a list of Response Factors.

   If the compound is not listed in Appendix 8.7 or you are measuring gas mixtures, then enter a value of 1.0. The concentration detected by 2020 will be multiplied by the response factor before it is displayed and logged.
9. Connect the supply of zero air. If you are using a gas bag with zero air, open the bag and connect the gas bag adapter to the inlet.
10. Select "Set", "Cal" and "Zero". The 2020 sets its zero point.
11. Select "Set", "Cal" and "Span". The 2020 asks for the span gas concentration. Enter the known span gas concentration, without pressing the ENTER key to confirm it.
12. Open the bag and then connect the gas bag adapter to the inlet. Press ENTER. 2020 sets its response factor.

Note: Readings may fluctuate slightly as the gas bag empties. Do not allow 2020 to evacuate the bag completely.

13. When the display reverts to the default display, 2020 is calibrated and ready for use. Remove the span gas bag from the inlet.

If 2020 is powered off in the middle of zeroing or spanning, it will power on displaying a Cal status. This indicates that you need to calibrate 2020. While the Cal status is active, all alarms are inactive.

rogramming the Cal Memories

2020 has 15 Cal Memories and can be calibrated with 15 different span gases or response factors if desired. To program the Cal Memories:

1. If you will be calibrating directly from the portable cylinder, connect a flow-match regulator (Part No. 350006) to each tank. You must use a separate regulator for each compound to prevent cross contamination.

   If you are using gas bags, prepare the bags of calibration gas as outlined in Section 3.3. Use a different gas bag and gas bag adapter for each concentration and for each type of calibration gas. You can use the same gas bag to zero all the Cal Memories, however, you must refill the bag before zeroing each Cal Memory.

2. Select "Set", "Cal" and "Mem".
3. Select the desired Cal Memory (1 to 15) with the "Next" and "Prev" keys.
4. Press "Chng" to change the parameters of the Cal Memory. Select "User" or "Lib".
5. If you selected "User", enter the name, response factor and alarm levels.
6. If you entered "Lib", use the "Next" and "Prev" keys to select the required library. See Appendix 8.8 for a list of Library entries.

> **Note:** It does not matter which Cal Memory is selected or which response factor is entered, 2020's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

7. Calibrate the instrument as described in Section 3.2.2 or 3.3.2. When the calibration is completed, the calibration information is automatically stored in the selected Cal Memory.
8. Repeat this procedure for each Cal Memory you need.

Whenever the instrument is calibrated, 2020 updates the selected Cal Memory only. Each Cal Memory must be calibrated at least once a day. Frequency of calibration will depend on ambient conditions and instrument response. If ambient conditions change or the response has drifted, a calibration must be performed for each Cal Memory to ensure reliable operation.

3.5. Response Factors for Gases and Vapors

3.5.1. General Information

In situations where only a single pure compound is present in air, 2020 should be calibrated with a standard of that specific compound as span gas. 2020's 15 Cal Memories can be used to store calibration information for 15 different span gases.

The displayed reading will always be influenced by any other photoionizable compounds present in the air sample.

> **Note:** Even if 2020 has been calibrated with a specific compound, its response is not specific and the presence of another ionizable impurity may render the numerical result invalid.

It is often impractical to carry a range of different standards into the field. Approximate results can be obtained by calibrating 2020 with the recommended span gas and entering the appropriate response factor. The response factor is based on the ratio of the response of the specific compound to the response of the span gas. The response factor multiplies 2020's reading then displays and records it.

Appendix 8.7 provides response factors from which approximations can be made for guidance purposes. Data extrapolated from the use of response factors must be regarded as interim and approximate only. Appendix 8.7 should be used only for concentrations up to 500 ppm of the specific compound, as response factors change with concentration.

3.5.2. Using Response Factors

1. Select "Set", "Cal" and "Mem".
2. Select the desired Cal Memory (1 to 15) with the "Next" and "Prev" keys.
3. Press "Set", "Cal" and "Mem" and "Chng" to change the parameters of the Cal Memory. Select "User" or "Lib".
4. If you selected "User", enter the name, response factor and alarm levels.

5. If you entered "Lib", use the "Next" and "Prev" keys to select the required library. See Appendix 8.8 for a list of Library entries.
6. Calibrate 2020 with zero air and 100 ppm isobutylene as described in Section 3.2.2 or 3.3.2.
7. Expose 2020 to the sample. The displayed reading is the approximate concentration of the specific compound.

The response factors in Appendix 8.7 serve only as a guide to concentrations measured by 2020.

Results are expected to be accurate to within +/-10 ppm or +/-25% of the displayed result, whichever is greater. Accuracy of response factors to other gases and vapors may differ from those listed in Appendix 8.7.

lanual Operation

As part of manual operation, you setup 2020 to monitor various locations. Since each location may contain different compounds and concentration ranges you can program a Cal Memory and the associated response factor and alarm level for up to 15 different applications. In this way you can sample numerous locations without having to re-calibrate 2020 at each location.

Prepare a monitoring schedule for you application. Your schedule should contain a list of sites that must be monitored and the Cal Memory that must be used when monitoring the site. Also include any reference information that will help you define the site and the monitoring application. If you create your schedule using spreadsheet software, you can later download 2020 data to a computer and then copy it into the spreadsheet for further calculations.

Once you have programmed 2020, and prepared a list of sites to be monitored, you will move around to each location and manually log data at each site.

1. You must determine the number of calibration standards that will be required to perform manual monitoring for your application. Program and calibrate all the calibration memories that you need. See Section 3.2 and 3.4.

Note: It does not matter which Cal Memory is selected or which response factor is entered, 2020's response is not specific to any one compound. The reading displayed always represents the total concentration of all ionizable compounds in the sample.

2. Ensure the 2020 is in PEAK mode. To change the mode, press ENTER and select "Disp". Press "Mode" and select PEAK.
3. Switch to manual operation. Press ENTER and then "Log". Select "Mode". Use the "Next" and "Prev" keys to scroll through the list. When Manual is displayed press ENTER. When you switch between interval and manual operation, the datalogger will be cleared. Press "YES" to confirm your selection and clear the datalogger. If you do not want to lose your previously recorded data, press "NO", then print or save the data to disk before changing to manual operation. See Sections 2.7.3 and 4.2 for printing and saving logged data.
4. The instrument status will change to "Loc".
5. Select the required Cal Memory for this location. Press ENTER and select "Set", "Cal" and then "Mem". Use the "Next" and "Prev" keys to select the desired Cal Memory.
6. Press the ENTER key and locate the first site on your schedule. The middle soft key is used to advance to the next measurement when you are operating in manual mode. Press the "Next" key. If you are not using manual operation, the "Next" key is not shown.
7. The instrument status will change to "BkGd". A background measurement must be made. When you have an accurate background, press "Next". 2020 will record the displayed concentration when you press the "Next" key.
8. The instrument status will now be "Samp". Take a sample measurement. When you have an accurate sample, press "Next". 2020 will record the displayed concentration when you press the "Next" key.
9. The instrument status will again be "Loc". Go to the next site on your schedule.

When you have completed your monitoring you can download the contents of the datalogger to a computer and add the 2020 data to your spreadsheet.

If you change from manual operation to an averaging interval, you will lose the contents of the datalogger. Print or save the data to disk before changing the interval. See Sections 2.7.3 and 4.2 for printing and saving logged data.

eparing for Field Operation

'.1. Field Check List

When using 2020 for field operation, the following items should be carried into the field to reduce or eliminate down time of the instrument.

If you are going to be in the field for a single 8-10 hour day, then you should include the following accessories:

- ❑ Spare battery pack (Part No. 350009)
- ❑ Spare UV lamp (Part No. 390011)
- ❑ 2020 multi-tool (Part No. 396012)
- ❑ Sample line (Part No. 390006)
- ❑ Calibration kit(s) (Part No. 390033)
- ❑ Calibration regulator (Part No. 350006)
- ❑ Tank(s) of calibration gas (Part No. 350012)
- ❑ Spare gas bag for zero air (Part No. 396017)
- ❑ Gas bag adapter for zero air (Part No. 396010)
- ❑ Supply of commercial zero air
- ❑ Spare inlet filters (Part No. 396015 or 396000)
- ❑ Dilution probe (Part No. 350013)
- ❑ Spare charcoal filters for the dilution probe (Part No. 395064 or 395067)
- ❑ Carrying case (Part No. 350010)
- ❑ User's manual (Part No. 350001)
- ❑ DC power cord (Part No. 350004)

Table 3 Check List for Field Operation

If you will be in the field for more than one day you should include the following additional items:

- ❑ AC adapter (Part No. 350001 or 396013)
- ❑ Printer (Part No. 380120)
- ❑ Cable kit (Part No. 350011)
- ❑ Computer and associated cables
- ❑ Serial to parallel converter (Part No. 380145)

Table 4 Additional Field Items

3.7.2. Operational Check List

Before beginning field work, set up and calibrate 2020 for your particular application. Ensure the instrument is in working order before heading into the field:

1. Press the "Set" and "Clock" keys and ensure the correct time is entered. Press the ENTER key and ensure the correct date has been entered.
2. Ensure the battery pack is fully charged. If you are unsure about the status of the battery, replace the battery pack with one that is fully charged. See Section 1.5.
3. Program and calibrate all the Cal Memories you need. See Section 3.4. After calibration is complete, sample the calibration gas and the bag of zero air to ensure 2020 has been calibrated correctly.
4. Select the correct operating mode. See Section 2.8.2.
5. Reset the TWA accumulator, the STEL moving average and the MAX. See Section 2.5.
6. You may want to delete all entries from the datalogger to avoid confusion between different days' data and to avoid running out of space in the datalogger. See Section 2.7.2.

Table C-1

PID Calibration Frequency and Preventative Maintenance

Maintenance	Frequency
store in protective casing	D
inspect equipment after use	D
check and recharge batteries	D
clean UV lamp and ion chamber	M or X
keep log book on instrument	D
have replacement meter available	D
return to manufacturer for service	X
calibration	after ten analyses or D

Notes:

D = daily
M = monthly
X = operator's discretion

CHARACTERISTICS OF THE PHOTOIONIZATION DETECTOR (PID)

I. Introduction

Photoionization detectors (PIDs) are used in the field to detect a variety of compounds in air. PIDs can be used to detect leaks of volatile substances in drums and tanks, to determine the presence of volatile compounds in soil and water, and to make ambient air surveys. If personnel are thoroughly trained to operate the instrument and to interpret the data, these PID instruments can be a valuable tool. Its use can help in deciding the level of protection to be worn, assist in determining the implementation of other safety procedures, and in determining subsequent monitoring or sampling locations.

Portable PIDs detect the concentration of organic gases as well as a few inorganic gases. The basis for detection is the ionization of gaseous species. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which ionizes molecules that have an ionization potential (IP) less than or equal to that rated for the UV source. Every molecule has a characteristic IP, which is the energy required to remove an electron from the molecule, thus yielding a positively charged ion and the free electron. These ions are attracted to an oppositely charged electrode, causing a current and an electric signal to the LED display. Compounds are measured on a parts per million (ppm) volume basis.

IV. Limitations

These instruments can monitor several vapors and gases in air. Many non-volatile liquids, toxic solids, particulates, and other toxic gases and vapors, however, cannot be detected with PIDs. Since the PIDs cannot detect all the chemicals that may be present at a sample location, a zero reading on either instrument does not necessarily signify the absence of air contaminants.

The instruments are generally not specific, and their response to different compounds is relative to the calibration gases. Instrument readings may be higher or lower than the true concentration. This effect can be observed when monitoring total contaminant concentrations if several different compounds are being detected at once. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must be taken when interpreting the data. Concentrations should be reported in terms of the calibration gas and span potentiometer or gas-select-knob setting.

PIDs are small, portable instruments and may not yield results as accurate as laboratory instruments. PIDs were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of known

contaminants in air, but interpretation becomes more difficult when trying to identify the individual components of a mixture. The instruments can be used as an indicator for combustible gases or oxygen deficiency.

This Plan intends for the PIDs to be used only as a guide for work area air monitoring to establish action levels (as defined in the Health and Safety Plan) and sample headspace screening to determine relative organic compound concentration.

ATTACHMENT C-2 (TO APPENDIX C)

MOLECULES AND COMPOUNDS DETECTED BY A PHOTOIONIZATION DETECTOR

ATTACHMENT C-2

Molecules and Compounds Detected by a Photoionization Detector (PID)

Some Atoms and Simple Molecules

	IP(eV)		IP(eV)
H	13.595	I_2	9.28
C	11.264	HF	15.77
N	14.54	HCl	12.74
O	13.614	HBr	11.62
Si	8.149	HI	10.38
S	10.357	SO_2	12.34
F	17.42	CO_2	13.79
Cl	13.01	COS	11.18
Br	11.84	CS_2	10.08
I	10.48	N_2O	12.90
H_2	15.426	NO_2	9.78
N_2	15.580	O_3	12.80
O_2	12.075	H_2O	12.59
CO	14.01	H_2S	10.46
CN	15.13	H_2Se	9.88
NO	9.25	H_2Te	9.14
CH	11.1	HCN	13.91
OH	13.18	C_2N_2	13.8
F_2	15.7	NH_3	10.15
Cl_2	11.48	CH_3	9.840
Br_2	10.55	CH_4	12.98

Paraffins and Cycloparaffins

Molecule	IP(eV)
methane	12.98
ethane	11.65
propane	11.07
n-butane	10.63
i-butane	10.57
n-pentane	10.35
i-pentane	10.32
2,2-dimethylpropane	10.35
n-hexane	10.18
2-methylpentane	10.12
3-methylpentane	10.08
2,2-dimethylbutane	10.06
2,3-dimethylbutane	10.02
n-heptane	10.08
2,2,4-trimethylpentane	9.86
cyclopropane	10.06
cyclopentane	10.53
cyclohexane	9.88
methylcyclohexane	9.85

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Alkyl Halides Molecule	IP(eV)
HCl	12.74
Cl_2	11.48
CH_4	12.98
methyl chloride	11.28
dichloromethane	11.35
trichloromethane	11.42
tetrachloromethane	11.47
ethyl chloride	10.98
1,2-dichloroethane	11.12
1-chloropropane	10.82
2-chloropropane	10.78
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chloro-2-methylpropane	10.66
2-chloro-2-methylpropane	10.61
HBr	11.62
Br_2	10.55
methyl bromide	10.53
dibromomethane	10.49
tribromomethane	10.51
CH_2BrCl	10.77
$CHBr_2Cl$	10.59
ethyl bromide	10.29
1,1-dibromoethane	10.19
1-bromo-2-chloroethane	10.63
1-bromopropane	10.18
2-bromopropane	10.075
1,3-dibromopropane	10.07
1-bromobutane	10.13
2-bromobutane	9.98
1-bromo-2-methylpropane	10.09
2-bromo-2-methylpropane	9.89
1-bromopentane	10.10
HI	10.38
I_2	9.28

Alkyl Halides Molecule	IP(eV)
methyl iodide	9.54
diiodomethane	9.34
ethyl iodide	9.33
1-iodopropane	9.26
2-iodopropane	9.17
1-iodobutane	9.21
2-iodobutane	9.09
1-iodo-2-methylpropane	9.18
2-iodo-2-methylpropane	9.02
1-iodopentane	9.19
F_2	15.7
HF	15.77
$CFCl_3$ (Freon 11)	11.77
CF_2Cl_2 (Freon 12)	12.31
CF_3Cl (Freon 13)	12.91
$CHClF_2$ (Freon 22)	12.45
$CFBR_3$	10.67
CF_2Br_2	11.07
CH_3CF_2Cl (Genetron 101)	11.98
$CFCl_2CF_2Cl$	11.99
CF_3CCl_3 (Freon 113)	11.78
$CFHBrCH_2Cr$	10.75
CF_2BrCH_2Br	10.83
CF_3CH_2I	10.00
$n\text{-}C_3F_7I$	10.36
$n\text{-}C_3F_7CH_2Cl$	11.84
$n\text{-}C_3F_7CH_2I$	9.96

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Aliphatic Alcohol, Ether, Thiol and Sulfides

Molecule	IP(eV)
H_2O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.16
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
H_2S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Aliphatic Aldehydes and Ketones

Molecule	IP(eV)
CO_2	13.79
formaldehyde	10.87
acetaldehyde	10.21
propionaldehyde	9.98
n-butyraldehyde	9.86
isobutyraldehyde	9.74
n-valeraldehyde	9.82
isovaleraldehyde	9.71
acrolein	10.10
crotonaldehyde	9.73
benzaldehyde	9.53
acetone	9.69
methyl ethyl ketone	9.53
methyl n-propyl ketone	9.39
methyl i-propyl ketone	9.32
diethyl ketone	9.32
methyl n-butyl ketone	9.34
methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
cyclopentanone	9.26
cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

Aliphatic Acids and Esters

Molecule	IP(eV)
CO_2	13.79
formic acid	11.05
acetic acid	10.37
propionic acid	10.24
n-butyric acid	10.16
isobutyric acid	10.02
n-valeric acid	10.12
methyl formate	10.815
ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
isobutyl formate	10.46
methyl acetate	10.27
ethyl acetate	10.11
n-propyl acetate	10.04
isopropyl acetate	9.99
n-butyl acetate	10.01
isobutyl acetate	9.97
sec-butyl acetate	9.91
methyl propionate	10.15
ethyl propionate	10.00
methyl n-butyrate	10.07
methyl isobutyrate	9.98

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Aliphatic Amines and Amides

Molecule	IP(eV)
NH_3	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-propyl amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	9.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

Other Aliphatic Molecules with N Atom

Molecule	IP(eV)
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Olefins, Cyclo-ofefins, Acetylenes

Molecule	IP(eV)
ethylene	10.515
propylene	9.73
1-butene	9.58
2-methylpropene	9.23
trans-2-butene	9.13
cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
isoprene	8.845
cyclopentene	9.01
cyclohexene	8.945
4-methylcyclohexene	8.91
4-cinylcylohexene	8.93
cyclo-octatetraene	7.99
acetylene	11.41
propyne	10.36
1-butyne	10.18

Some Derivatives of Olefins

Molecule	IP(eV)
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
$CF_3CCl{=}CClCF_3$	10.36
$n\text{-}C_5F_{11}CF{=}CF_2$	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

ATTACHMENT C-2 (cont'd)

Molecules and Compounds Detected by a Photoionization Detector (PID)

Aromatic Compounds	
Molecule	IP(eV)
benzene	9.245
toluene	8.82
ethyl benzene	8.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
alpha-methyl styrene	8.35
ethynylbenzene	8.815
napthalene	8.12
1-methylnapthalene	7.69
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

Aromatic Compounds	
Molecule	IP(eV)
phenyl isothiocyanate	8.520
benzonitrile	9.705
nitrobenzene	9.92
aniline	7.70
fluoro-benzene	9.195
chloro-benzene	9.07
bromo-benzene	8.98
iodo-benzene	8.73
o-dichlorobenzene	9.07
m-dichlorobenzene	9.12
p-dichlorobenzene	8.94
1-chloro-2-fluorobenzene	9.155
1-chloro-3-fluorobenzene	9.21
1-chloro-4-fluorobenzene	8.99
o-fluorotoluene	8.915
m-fluorotoluene	8.915
p-fluorotoluene	8.785
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
o-bromotoluene	8.79
m-bromotoluene	8.81
p-bromotoluene	8.67
o-iodotoluene	8.62
m-iodotoluene	8.61
p-iodotoluene	8.50
benzotrifluoride	9.68
o-fluorophenol	8.66

Molecules and Compounds Detected by a Photoionization Detector (PID)

Heterocyclic Molecules

Molecule	IP(eV)
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85

Miscellaneous Molecules

Molecule	IP(eV)
ethylene oxide	10.565
propylene oxide	10.22
p-dioxane	9.13
dimethoxymethane	10.00
diethoxymethane	9.70
1,1-dimethoxyethane	9.65
propiolactone	9.70
methyl disulfide	8.46
ethyl disulfide	8.27
diethyl sulfite	9.68
thiolacetic acid	10.00
acetyl chloride	11.02
acetyl bromide	10.55
cyclo-$C_6H_{11}CF_3$	10.46
(n-C_3F_7)(CH_3)C=O	10.58
trichlorovinylsilane	10.79
$(C_2F_5)_3N$	11.7
isoprene	9.08
phosgene	11.77

Notes:

Reference: HNu Systems, Inc., 1985
IP = Ionization Potential

ATTACHMENT C-4 (TO APPENDIX C)

PID CALIBRATION AND OPERATION PROCEDURES

ATTACHMENT C-3 (TO APPENDIX C)

PHOTOIONIZATION DETECTOR CALIBRATION AND MAINTENANCE LOG

APPENDIX D

MONITORING WELL INSTALLATION
AND CONSTRUCTION PROCEDURES

INSTALLATION PROCEDURES FOR MONITORING COMPLETION

I. Introduction

Soil borings, which will be completed as monitoring wells, shall be advanced using the hollow-stem auger or driven casing drilling method, as specified by the supervising geologist/engineer. No oils or grease will be used on equipment in the boreholes (e.g., drill rod, casing, sampling tools).

II. Procedures for Well Installation

Upon completion of a borehole to the desired depth, the well will be installed by placing the screen and casing assembly with bottom cap through the hollow axis of the auger column. A washed silica sand filter pack will be placed in the annular space adjacent to the screen to at least 1 foot above the top of the screen. If a sand pack is not warranted, the auger string will be pulled back to allow the native aquifer material to collapse two to three feet above the top of the screen. An approximate 1 to 2 feet of hydrated bentonite seal will then be added to the annulus between the well casing and the borehole wall to allow for proper sealing. During placement of sand and bentonite, frequent measurements will be made to check the height of the sand pack and thickness of bentonite with a weighted steel or fiberglass tape measure.

A protective locking steel casing shall be located over the standpipe, unless a curb box is warranted, extending approximately 2 feet below grade and 2 to 3 feet above grade, and will be secured by a cement seal. The cement seal shall extend laterally at least one foot in all directions from the protective casing and shall slope gently away to drain water away from the well.

A diagram of a typical monitoring well construction is shown as Attachment D-1. The supervising geologist/engineer shall specify the monitoring well design and materials to be used to the drilling contractor before installation.

The supervising geologist/engineer is responsible for recording in the field notebook the exact well construction details and measurements as relayed by the drilling contractor. Both the supervising geologist/engineer and drilling contractor are responsible for tabulating all well materials used, such as length of casing and screen, and bags of bentonite, cement, and sand.

III. Survey

A field survey control program will be conducted using standard instruments and survey techniques to document well location and ground surface, inner, and outer casing elevations.

IV. Well Development

All monitoring wells yielding water will be developed, or cleared of fine-grained materials that have settled in the well or within the well screen filter pack during installation (Appendix E).

V. Equipment Cleaning

All drilling equipment and associated tools, including augers, drill rods, wrenches, and any other equipment or tools that may have come in contact with soil, shall be cleaned in accordance with the procedures outlined in Appendix H.

VI. Disposal Methods

All water generated during cleaning procedures will be collected and contained on site in appropriately labeled DOT-approved, 55-gallon containers.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures and from soil sampling and handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon containers for disposal at an appropriate waste facility, as necessary.

ATTACHMENT D-1 (TO APPENDIX D)

MONITORING WELL CONSTRUCTION DIAGRAM

APPENDIX E

MONITORING WELL DEVELOPMENT PROCEDURES

MONITORING WELL DEVELOPMENT PROCEDURES

I. Introduction

All monitoring wells yielding water will be developed (i.e., cleared of fine-grained materials and sediments) to ensure that the screen is transmitting groundwater that is representative of the surrounding formation waters. Development will be accomplished by surging or evacuating well water by pumping or other acceptable methods (i.e., bailing). The well will be developed until it yields relatively sediment-free water. Air lift methods of evacuating well water will not be utilized for development.

When developing a well using the pumping method, dedicated polyethylene tubing from the pump is extended to the screened portion of the well and moved up and down the screened interval until the well yields clear water. An alternate procedure for well development involves moving groundwater through the well screen using a centrifugal or a submersible pump. The centrifugal pump uses atmospheric pressure to lift water from the well and, therefore, can only be used where the depth to water is less than 25 feet. The submersible pump is attached to the end of the tubing that enters the well, pushing the water to the surface, and is particularly effective where the water table is greater than 25 feet below land surface. Surging will be repeated as many times as necessary within the well screen interval until the groundwater becomes relatively clear.

II. Materials

Materials required for well development using a pump include:

- Personal protective equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Appendix H);
- Photoionization detector (PID) to measure headspace vapors;
- Polyethylene tubing (dedicated to each well location);
- Plastic sheeting;
- Power source (generator);
- Field notebook;

- Keys to wells;
- Graduated pails;
- Bottom-loading bailer;
- Pump;
- Surge block, if necessary;
- Glass container;
- 55-gallon DOT-approved drums; and
- Temperature/pH/specific conductance meter.

III. Procedures

A detailed procedure for well development follows:

1. Don appropriate personal protective equipment (as required by the Health and Safety Plan).
2. Place plastic sheeting around the well.
3. Clean all equipment entering each well as specified in Appendix H and then place on the plastic sheeting.
4. Unlock and open the well cover while standing upwind of the well. Remove the well cap. Measure headspace vapors as described in Appendix C.
5. Lower a bottom-loading bailer into the well and extract a bailer volume of groundwater.
6. Pour the groundwater into a glass container and record the temperature, pH, and specific conductance.

Development With a Pump

1. Attach appropriate pump and lower tubing into well.
2. Turn on pump. If well runs dry, shut off pump and allow the well to recover.
3. Contain all water in 55-gallon DOT-approved drums, if necessary.
4. Surge several times by raising and lowering the tubing and attached pump in the well to remove fine-grained material.
5. Repeat Step 4 until groundwater appears relatively sediment-free.

6. Obtain another groundwater volume and record the temperature, pH, and specific conductance.
7. Raise the developing equipment 2 feet and repeat Step 4 and 5.
8. Repeat Step 7 until the entire well screen has been developed.
9. The well has been adequately developed when it yields relatively sediment-free water and the temperature, pH, and specific conductance have stabilized.
10. Upon completion of surging of the well, remove the pump tubing from the well.
11. Secure the well cover, and lock the well.
12. Place plastic sheeting and tubing in plastic bags for appropriate disposal, and clean the pump as specified in Appendix H.

Development With a Bottom-Loading Boiler

1. Lower bailer to bottom of well, retrieve and discharge ground water to appropriate container.
2. Surge several times by raising and lowering bailer within the water column to remove fine-grained material.
3. When the bottom of the well taps "hard", the majority of the fine-grained sediments have been removed.
4. Continue bailing procedures until the water yields relatively sediment-free water and the temperature, pH and specific conductance have stabilized.
5. Upon completion of well development, secure the well cover, and lock the well.
6. Place plastic sheeting and rope in plastic bags for appropriate disposal and clean the bailer as specified in Appendix H.

IV. Disposal Methods

All water generated during cleaning and development procedures will be collected and contained in appropriately labeled, DOT-approved, 55-gallon containers.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures and from soil sampling and handling activities, will be

placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon containers for disposal at an appropriate waste facility, as necessary.

APPENDIX F
WATER LEVEL MEASUREMENT PROCEDURES

WATER LEVEL MEASUREMENT PROCEDURES

I. Introduction

Water level measurements will be used in the development of groundwater potentiometric surface maps. The water levels will be obtained using an electric water level probe.

II. Materials

The following materials, as required, shall be available during water level measurement activities.

- Photoionization detector (PID) to measure headspace vapors;
- Personal protective equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Appendix H);
- Appropriate forms and field notebook;
- Keys for wells;
- Water level probe;
- Hacksaw or waterproof marker;
- Measuring tape (Engineer's 6-foot rule);
- Weighted fiberglass or steel tape; and
- Watch (to record time of day).

III. Procedures

1. Record the site and well number on the Water Level Record (Attachment F-1) or field notebook along with other appropriate information collected during the water level measurement.
2. Don personal protective equipment (as required by the Health and Safety Plan).
3. Clean the water level probe and cable in accordance with the cleaning procedures in Appendix H.
4. Unlock and open the well cover while standing upwind of the well. Remove the well cap. Measure headspace vapors as described in Appendix C.
5. Locate the measuring reference point on the well casing. If one is not found, initiate a reference point by notching the inner and outer casings with a hacksaw or by using a waterproof marker.

If a well has both inner and outer casings, use the top of the inner casing as the reference point. All down-hole measurements will be taken from the reference point.

6. Lower the water level probe until it reaches the water surface. Measuring to the nearest hundredth of a foot, record the depth to water from the reference point.
7. Lower the water level probe or weighted fiberglass or steel tape to the bottom of well. Measure and record the depth of the well from the reference point to the nearest hundredth of a foot. Again, record the reference point used. If weights are suspended from the water level probe, adjust the recorded depth for the length of the weight.
8. Remove weighted fiberglass or steel tape or water level probe from the well.
9. Clean the water level probe or tape and cable in accordance with the cleaning procedures in Appendix H.
10. Compare depth of well to previous records.
11. Close and lock the well when all activities are completed.

ATTACHMENT F-1 (TO APPENDIX F)

WATER LEVEL RECORD

APPENDIX G

GROUNDWATER PURGING AND SAMPLING PROCEDURES

GROUNDWATER PURGING/EVACUATION AND SAMPLING PROCEDURES

I. Introduction

During precipitation events, unless the well head and sampling equipment are covered, groundwater sampling will be discontinued until precipitation ceases. In addition, no monitoring wells will be sampled until at least two weeks following well development (or redevelopment) to allow equilibrium of the well with the aquifer.

II. Materials

The following materials shall be available, as required, during groundwater sampling:

- Photoionization detector (PID) to measure headspace vapors;
- Personal protective equipment (as required by the Health and Safety Plan);
- Cleaning equipment (as required in Appendix H);
- Plastic sheeting;
- Bailer (stainless steel or Teflon^{R});
- Polypropylene or nylon rope;
- Sampling pump;
- Water level probe;
- Engineer's 6-foot rule;
- Weighted fiberglass or steel tape;
- Watch;
- Pre-measured bucket (if required);
- Temperature/pH/conductivity meter;
- Turbidity meter;
- Glass container;
- Insulated coolers, ice, and appropriate packing material;
- Ziploc-type bags;
- Large heavy-duty garbage bags;

ATTACHMENT G-1 (TO APPENDIX G)

GROUNDWATER SAMPLING FIELD LOG

ATTACHMENT G-1 (TO APPENDIX G)

GROUNDWATER SAMPLING FIELD LOG

GROUNDWATER SAMPLING FIELD LOG

Project Name_____
Well No. _____
Key No. _____
PID Background ___ Well __
Draeger Tubes - Background __

Project No. _____
Site Name _____
Sampling Personnel _____
Date _____ Time In ____ Out _____
Weather _____
Well ____ Compound _____

I. Well Information
Reference Point Marked on Casing Y N
Well Diameter __ TIC __ TOC
Well depth _____ TOC, TIC
Water table depth __ TOC, TIC
Slug test Y N

Length of Inner Casing
__ above grade
Length of Outer Casing
__ above grade
Redevelop Y N

II. Well Water Information
Length of water column ____
Volume of water in well ___
Pumping rate of pump ____
Volume of bailer _____

__ x water volume in well to be removed
Minutes of pumping_____
Number of bails _____

III. Evacuation Information
Volume of water removed from well _____
Did well go dry? Y N

Evacuation method:
Bailer ( ) Pump ( )
Evacuation rate _____

	Initial	After 1 Volume Removed	After 2 Volumes Removed	After 3 Volumes Removed
Temperature	___	___	___	___
pH	___	___	___	___
Specific Conductance	___	___	___	___

IV. Well Sampling

Container	Preservative	Time Sampled	Analysis	Lab Sample No.

V. Groundwater Characteristics After Sample Collected
Temperature ___
Conductivity ___
pH ___ ___ 10; ___4; ___ 7

Film __
Redline? Y N

(calibration standard readings)

VI. Miscellaneous Observations/Problems

VII. Sample Destination
Laboratory _____ Via ___ Sent By __

_____
Field Sampling Coordinator

ATTACHMENT G-2 (TO APPENDIX G)

LOW-FLOW GROUND WATER SAMPLING PROCEDURES

Low Flow Purging and Sampling Procedure for Ground Water Samples

Procedure Number:
Revision Date:
Revised By:
Current Status:

Purpose

The purpose of low flow purging and sampling ground water is to collect ground water samples that are indicative of mobile organic and inorganic compounds at ambient flow conditions.

Equipment

1. Extraction Device – adjustable rate, submersible pumps are preferred (refer to spcific instructions for hydrogen sampling).
2. Tubing: 1/4-3/8 inch Teflon or Teflon-lined polyethylene tubing.
3. Water Level Measuring Device(s): capable of measuring to 0.01 foot accuracy.
4. Flow measurement supplies: graduated cylinder and stop watch.
5. Power source: generator, nitrogen tank, etc.
6. Portable Photoionization Detector (PID) calibrated to a benzene reference,
7. Field parameter monitoring instruments – pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature.
8. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).
9. Notebooks and forms
10. Sample Bottles.
11. Sample preservation supplies
12. Sample labels
13. Well construction data, location map, field data from first sampling event.
14. Cooler(s)
15. Site-Specific Health and Safety Plan (HASP)

Preliminary Site Activities

Immediately after opening the well casing, screen the interior of the well with a portable PID. Compare the recorded levels with the ambient air and the relevent OSHA standards identified in the site-specific Health and Safety Plan (HASP).

If the well casing does not have a reference point (usually a V-cut or indelible mark on the well casing), make one. Describe its location and record the date of the mark in the logbook.

A water level measurement round should be performed before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the

water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

Procedure

a. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for each well. If possible, keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

b. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used, initialize starting condition.

c. Purge Well

Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed so that there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown achieved exceeds 0.3 feet, but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 – 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to

Add preservative, as required by analytical methods, to samples immediately after they re collected if the sample containers are not pre-preserved. Check analytical methods (e. g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25-50 ml of ground water prior to sample collection. Preserve filtered water acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

b. Post Sampling Activities

If recording pressure transducer is used, re-measure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the total well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Decontamination

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade) (optional).

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump (optional).

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four-inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner (optional).

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

QA/QC

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples

must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a bath may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per sample cooler.

Field duplicate
Equipment blank
Trip blank (VOCs)
Temperature blank (one per sample cooler)

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).
If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

Field Notebook

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification

Well depth and measurement technique

Static water level depth, date, time and measurement technique

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s)

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

Report

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data usability.

WELL PURGING-FIELD WATER QUALITY MEASRUEMENTS FORM

Location (Site/Facility Name) _____
Well Number _____ Date _____
Field Personnel _____
Sampling Organization _____
Identify MP _____

Depth to _____/_____ of screen
(below MP) top bottom
Pump Intake at (ft. below MP) _____
Purging Device; (pump type) _____

Clock Time	Water Depth below MP	Pump Dial[1]	Purge Rate ml/min	Cum.Volume Purged liters	Temp. °C	Spec. Cond.[2] uS/cm	pH	ORP/Eh[3] mv	DO mg/L	Turbidity NTU	Commen

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. uSiemens per cm (same as umhos/cm) at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

APPENDIX H

EQUIPMENT CLEANING PROCEDURES

I. Introduction

Equipment cleaning areas will be located within or adjacent to a specific work area, as specified in the Health and Safety Plan. The equipment cleaning procedures described herein include in the field cleaning of sampling equipment. The sampling equipment consists of soil sampling equipment, well construction materials, groundwater sampling devices, water testing instruments, and other activity-specific sampling equipment. The non-disposable equipment will be cleaned after completion of each sampling event. Cleaning procedures will be monitored by the performance of Quality Assurance/Quality Control (QA/QC) checks through sampling and analysis as described in Section 5.4.

II. Materials

The following materials, as required, shall be available during equipment cleaning:

- Personal protection equipment (as required in the Health and Safety Plan);
- Distilled/deionized water;
- Non-phosphate soap;
- Tap water;
- Appropriate cleaning solvent (e.g., methanol);
- Nitric acid;
- High-pressure water/steam cleaning unit;
- Wash basins, buckets;
- Brushes;
- Polyethylene sheeting;
- Aluminum foil;
- DOT-approved 55-gallon drum or garbage can;
- Large heavy-duty garbage bags;
- Spray bottles (to hold soapy water, tap water, distilled/deionized water, methanol, or nitric acid); and
- Disposable [polyvinyl chloride (PVC) or nitrile] gloves.

III. Storage of Equipment

All decontaminated sampling equipment will be stored in a clean environment and, where appropriate, the equipment will be covered with aluminum foil.

IV. Safety Procedures During Equipment Cleaning

1. Personnel will wear the following personal protection equipment when cleaning smaller sampling equipment (e.g., split-spoon sampler, trowels):
   - Safety glasses, goggles, or a splash shield; and
   - PVC or nitrile outer gloves.
2. Personnel will wear the following additional personal protection equipment when cleaning larger equipment (e.g., drilling rigs) with a high-pressure water/steam cleaning unit:
   - Safety glasses, goggles, and/or splash shield; and
   - PVC or nitrite outer gloves.
3. All solvent rinsing will be conducted in an adequately ventilated area.
4. All solvents transported into the field will be stored and packaged in appropriate containers with care taken to avoid exposure to extreme heat.
5. Handling of solvents will be consistent with the manufacturer's Material Safety Data Sheets (MSDS). The MSDS for the solvent used during decontamination (methanol) can be found in the Health and Safety Plan.

V. Field Cleaning Procedures

A. Cleaning Station

Selection of a field equipment cleaning station location will be important. It will be located away from the immediate work area so as not to adversely impact the cleaning procedure, but close enough to the sampling teams to keep equipment handling to a minimum.

A designated area will be established to conduct all cleaning at each work area of the Site. All equipment such as drill rigs, backhoes, and other mobile equipment will receive an initial cleaning prior

to use at the Site. The frequency of subsequent cleaning while on site will depend on the extent to which the equipment is actually used in relation to the collection of environmental samples.

B. Decontamination of Smaller Sampling Equipment

Cleaning of smaller sampling equipment (e.g., split-spoon samplers, bailers, trowels) will follow the decontamination procedures presented in Table H-1. The first step, soap and tap water wash, is to remove all visible particulate matter and residual oil and grease. This may be preceded by a steam cleaning to facilitate solids removal. When samples are to be analyzed for organic constituents, the soap and tap water wash will be followed by a tap water rinse to remove the detergent and a rinse sequence of solvent (e.g., methanol) and distilled/deionized water. When analyzing for inorganic constituents, the soap and tap water wash will be followed by a nitric acid rinse and a distilled/deionized water rinse.

C. Decontamination of Submersible Pumps

Submersible pumps may be used to evacuate stagnant groundwater in the well casing. The pumps will be cleaned and flushed between uses. This cleaning process will consist of an external detergent wash and tap water rinse, or a steam cleaning of pump casing, hose, and cables followed by a flushing with potable water through the pump. This flushing will be performed with the use of a clean plastic overpack drum or 2-inch diameter PVC tube filled with potable water. The pump will run long enough to flush water sufficiently through the pump housing and hose. Care should be taken to avoid contact with the pump casing and water in the drum while the pump is running to avoid electric shock. The pump and hose will be placed on clean polyethylene sheeting to avoid contact with the ground surface.

D. Decontamination of Heavy Equipment

Other equipment and material associated with sampling events will be cleaned prior to use. Items such as down-hole tools, drill tools and auger flights could contain potential sources of interference to environmental samples. The sampling equipment may have come in contact with the materials

adjacent to the matrix being sampled or media may be attached to the actual sampling equipment. Heavy equipment may also retain contaminants from other sources such as roadways or storage areas or material from previous job sites that were not adequately removed. For these reasons, it is important that these items be cleaned prior to use during the Site Investigation.

Two methods are used for cleaning heavy equipment: steam cleaning and manual scrubbing. Steam cleaning can remove visible debris. Since steam cleaners provide a high pressure medium, they are very effective for solids removal. They are also easy to handle and generate low volumes of wash solutions.

A second method involves manual scrubbing of equipment using brushes and the procedures detailed in Table H-1. This procedure can be as effective as steam cleaning and is preferred in situations where steam cleaning fails to remove visible materials. Disadvantages to manual scrubbing are that it is labor intensive and it generates large volumes of wash and rinse solutions.

Heavy equipment will be thoroughly steam cleaned or manually scrubbed upon arrival on site and when moved between sampling locations. Drill rig items such as auger flights, drill rods, and drill bits will be cleaned before changing sample locations, within a temporary on-site decontamination area.

E. Decontamination of Water Level Probe

Water level probes, or meters, will be cleaned with a soapy/water solution, followed by a potable water rinse, each applied with a spray bottle, or 5-gallon bucket containing the appropriate media. Following the wash and rinse, the probe and lead wire system will be dried with disposable paper towels.

VI. Disposal Methods

All water generated during cleaning procedures will be collected and contained on site in appropriately labeled, DOT-approved, 55-gallon containers.

Personal protective equipment, such as gloves, disposable clothing, and other disposable equipment, resulting from personnel cleaning procedures, will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon containers for disposal at an appropriate waste facility, as necessary.

TABLE H-1

EQUIPMENT CLEANING

The field sampling equipment cleaning procedures when analyzing for organic constituents are as follows:

1. Non-phosphate soap and tap water wash;
2. Tap water rinse;
3. Solvent rinse (e.g., methanol);
4. Distilled/deionized water rinse; and
5. Allow to air dry.

The field sampling equipment cleaning procedures when analyzing for inorganic constituents are as follows:

1. Non-phosphate soap (Alconox^{R} or equivalent) and tap water wash;
2. 10% nitric acid rinse;
3. Distilled/deionized water rinse; and
4. Allow to air dry.